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ANVIK RIVER SALMON ESCAPEMENT STUDY, 1990

By

Gene J. Sandone

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INTRODUCTION

The Anvik River (Figure 1) is the largest producer of summer chum salmon (*Oncorhynchus keta*) in the Yukon River drainage. Buklis (1982a) estimated that the Anvik River alone accounts for 35% of the total production. Other known major spawning populations occur in the Andreafsky, Rodo, Nulato, Gisasa, Hogatza, Melozitna, Tozitna, Chena, and Salcha Rivers (Figure 1). Summer chum salmon spawn in lesser numbers in other tributaries of the Yukon River. Chinook (*O. tshawystcha*) and pink (*O. gorbuscha*) salmon occur in the Anvik River coincidentally with summer chum salmon. Coho salmon (*O. kisutch*) are known to occur in the fall.

Commercial and subsistence harvests of Anvik River summer chum salmon occur throughout the mainstem Yukon River from the coast of the delta to the mouth of this tributary stream. Set and drift gill nets are the legal fishing gear in Districts 1, 2, and 3, while set gill nets and fishwheels are used in District 4. Most of the effort and harvest on this stock occurs in Districts 1 and 2 and in the lower portion of District 4. Fish taken commercially in the lower three districts are fresh frozen, while District 4 is primarily a roe fishery due to poor flesh quality and distance from market. Commercial and subsistence summer chum salmon fisheries in the remainder of District 4 and in District 6 are supported by stocks other than the Anvik River stock. Very few summer chum salmon are harvested in District 5 due to the lack of significant spawning populations in that portion of the drainage.

A stock identification study on Yukon River chum salmon using protein electrophoresis techniques is being conducted by the United States Fish and Wildlife Service (USFWS). This study was initiated in 1987 and only preliminary results are available. A small-scale stock identification investigation using scale pattern analysis was conducted by the Alaska Department of Fish and Game (ADF&G). Results of this pilot study indicated that separation of chum salmon stocks by scale pattern analysis is probably not feasible (Wilcock 1988).

In the lower portion of the Yukon River (Districts 1, 2, and 3), run timing of chinook and summer chum salmon greatly overlap from river-ice breakup until June or early July. During this time period management of the lower Yukon River has traditionally been directed at chinook salmon. The District 4 commercial fishery has been directed primarily at chum salmon. Subsistence fisheries in all four districts take summer chum salmon primarily for sled dog food. In the lower Yukon area, large-mesh gill nets (stretch mesh greater than 6") were employed to target chinook salmon for harvest. Although large-mesh gill nets were very efficient in harvesting chinook salmon, the associated harvest of summer chum salmon was small in relation to the size of the run. Prior to the 1985 season, however, the Alaska Board of Fisheries, in an attempt to increase the harvest of summer chum salmon in the lower river, directed that special small-mesh (stretch mesh maximum of 6 in) fishing periods should be allowed during the chinook salmon season if the summer chum salmon run is of sufficient size to support the additional exploitation, and that the incidental harvest of chinook salmon during these small-mesh fishing periods did not adversely affect conservation of that species. During the 1986, 1988, and 1989 seasons, management strategies which restricted gill net mesh size to a maximum of 6 in were implemented during the directed chinook salmon season to take advantage of very strong summer chum salmon runs. This management strategy allowed more fishing time and increased the exploitation on the summer chum salmon run. The incidental harvest of chinook salmon during these special small-mesh periods did not adversely affect the status of the chinook salmon resource. Although small mesh periods were again used to harvest summer chum in the lower Yukon River fisheries during the developing stages of the summer chum run in 1990, restricted-mesh fishing periods were suspended due to the unexpected poor summer chum salmon return. Summer chum salmon commercial harvests in the lower Yukon area were limited to near the lower end of the recently established guideline harvest levels (ADF&G 1990).

Summer chum salmon escapements to the major spawning areas in the Yukon River drainage have been estimated by aerial survey from fixed-wing aircraft on a consistent basis since the early 1970's. Aerial surveys are subject to error and variability due to weather, stream conditions, timing of the survey relative to spawning stage, and subjectivity and experience on the part of the observer. The counts obtained are only indices of abundance since not all salmon present on the day of the survey are usually seen, and earlier and later spawners are not present. However, these indices, if obtained under standardized conditions, can be used to monitor the relative abundance of spawning escapements. Aerial surveys are the most feasible method of assessing salmon escapements in terms of cost and staff limitations in a watershed as immense and remote as that of the Yukon River. Escapement objectives have been established for both chinook and chum salmon in selected tributary streams for which there is a sufficient historical data base (Whitmore, et al. 1990).

Intensive studies are conducted for a few important and representative tributary stream salmon spawning populations in addition to the aerial survey program. The Anvik and Andreafsky Rivers were chosen for summer chum salmon research studies in 1972 and 1981, respectively. Project results for the these escapement studies have been reported by Lebida (1973), Trasky (1974, 1976), Mauney (1977, 1979, 1980), Mauney and Geiger (1977), Mauney and Buklis (1980), Buklis (1981, 1982b, 1983, 1984a, 1984b, 1985, 1986, 1987), and Sandone (1989, 1990). Because of severe budget restrictions in 1989, the Andreafsky River project was discontinued. This report presents results of the Anvik River study for the 1990 field season.

The Anvik River originates at an elevation of 1,300 feet and flows in a southerly direction approximately 120 miles to its mouth at mile 318 of the Yukon River (Figure 2). It is a narrow runoff stream with a substrate mainly of gravel and cobble. However, bedrock is exposed in some of the upper reaches. The Yellow River is a major tributary of the Anvik and is stained with tannic acid runoff. Downstream of the Yellow River confluence the Anvik River changes from a moderate gradient system to a low gradient system meandering through a much broader flood plain. Water clarity is reduced downstream of the Yellow River. Numerous oxbows, old channel cutoffs and sloughs are found throughout the lower river.

Salmon escapement was enumerated from two counting tower-sites above the Yellow River from 1972 to 1978. A site 5.5 miles above the Yellow River was used from 1972 to 1975, and a site at Robinhood Creek, 2.5 miles above the Yellow River, was used from 1976 to 1978. Aerial surveys were flown each year (except 1974) in fixed-wing aircraft to estimate salmon abundance below the tower site. High and turbid water often affects the accuracy of visual salmon enumeration from counting towers and aircraft.

The Electrodynamics Division of the Bendix Corporation developed a side-scanning sonar counter during the 1970's capable of detecting and counting salmon migrating along the banks of tributary streams. The sonar counter is designed to transmit a sonic beam along a 60 foot aluminum tube, or substrate. Echoes from salmon passing through the beam are reflected back to the transducer. The system electronics interpret the strength and number of the echoes, and tally salmon counts. Criteria for strength and frequency of the echoes are designed to optimize counting of salmon and minimize any non-salmon counts (i.e. debris or other fish species). Salmon escapement was enumerated by sonar beginning in 1979, replacing and proving superior to the tower-counting method. One sonar counter has been installed on each bank of the Anvik River near Theodore Creek each year. Aerial survey data indicates that virtually all summer chum salmon spawners are found upstream of this site.

METHODS AND MATERIALS

Sonar counters were operated without artificial aluminum substrate tubes throughout the season for the sixth consecutive year. Each sonar transducer was mounted on a rectangular aluminum frame. The east and west bank sites used in previous years were probed to locate uniform river bottom gradients that would provide optimum surfaces for insonification. Two steel pipes were set into the river bottom on each side of the river, onto which the transducer frames were guided by side-mounted steel sleeves. Counting ranges were initially set to 60 ft. Weirs prevented salmon passage inshore of the transducer on each bank. Transducers were moved inshore or offshore and counting ranges were adjusted as required by fluctuating water levels.

During the 1990 season 1981-model sonar counters were used on both banks of the Anvik River. These model counters divided the counting range in 16 sectors. Sectors were consecutively numbered from the west to east bank. Therefore, sectors 1 - 16 were associated with the west bank counter while sectors 17 - 32 were associated with the east bank counter. Sector number 1 and 32 corresponded to the near-shore sector on the west and east bank, respectively.

Missing hourly sector counts, not recorded as a result of debris or printer malfunction, were estimated by averaging the counts in the same sector for the hour before and after the count in question. When salmon were not counted for a large portion of a day, or a large portion of the counting range within a day, the daily count total for that day was estimated by dividing the partial daily count by the mean proportion of corrected counts for the corresponding hours or sectors for the day before and after the day of the data omission which had full 24-h counts. The estimated counts for the sectors or hours for which counts were not recorded were distributed by sector or hour based on the mean count-distribution pattern of the corresponding sectors or hours on the day before and day after the data omission. When counting was not conducted for a full day, the salmon passage for that day was estimated as the mean of the salmon passage for the day before and after the day for which sonar counts were not available. The estimated daily counts were distributed by hour and sector based on the mean distribution pattern of corrected counts of the day before and after the missing count day.

Each sonar counter was calibrated five times daily by observing fish passage with an oscilloscope for an approximate 15-minute period. Five daily calibration times were deemed adequate to monitor the diel timing pattern of the salmon migration. Calibrations were normally conducted during the hours of 0400, 0800, 1300, 1800, and 2400. However, during the initial and last days of the project when fish passage was low, calibrations were conducted during the hours of 0800, 1300, 1800, and 2400.

Salmon passing through the sonar beam produce a distinct oscilloscope trace. Sonar and oscilloscope counts for each calibration period were related in the formula: Q=SS/SC, where SS = side scan sonar counts, and SC = oscilloscope counts. The fish velocity control setting was adjusted if Q varied from 1.0 by 15% during the 1300 and the 2400 calibration hours and when the ratio varied from 1.0 by more than 25% during all other calibration hours. The existing fish velocity setting was multiplied by Q to obtain the correct new setting. After adjustments were made to the sonar unit an additional 15-minute calibration was made to ensure that the ratio was within accepted limits and to initialize the counting period. A record was kept of all adjustments to the sonar equipment. Attempts were also made to visually enumerate fish passage from 10 ft counting towers during sonar calibration times as a further check on sonar accuracy. Polaroid sunglasses were worn to reduce water surface glare. However, attempts to visually enumerate salmon during calibration times were discontinued from the west bank when it became apparent that the presence of the observer on the tower interfered with the normal passage of salmon past the sonar site.

Daily sonar counts were adjusted based on bank-specific, period calibration data. Calibration periods were defined by the time of each calibration. For each bank, unadjusted sonar counts for each period were multiplied by the periodic adjustment factor, calculated as the sum of the two oscilloscope counts associated with the calibrations which defined the period divided by the sum of the two associated sonar counts for that period. The resulting corrected sonar counts for each period within a day were summed, yielding the estimated summer chum salmon passage for that day for that bank. The daily adjustment factor was found by dividing the daily corrected counts by the sonar counts. The daily passage of salmon was determined by summing the daily bank estimates. Mean and standard deviation of date of passage were calculated following the method presented by Mundy (1982).

Corrected period counts were totaled for each day, for each bank using a portable computer. Since summer chum salmon greatly outnumber chinook and pink salmon, and the counters do not distinguish between species of salmon, all sonar counts were attributed to summer chum salmon passage. A separate escapement estimate for chinook salmon was obtained by aerial survey. During the 1990 season pink salmon were not observed either from the tower or in beach seine samples.

Hourly sonar counts were corrected by applying the associated bank-specific periodic adjustment factor to the raw hourly count data within the period.

Sector counts were corrected by using the overall daily correction factor derived by dividing the sum of the corrected hourly counts by the sum of the raw hourly counts. These corrected hourly and sector counts were used to determine the temporal and spatial distribution of the summer chum salmon run. Season strata used for the comparison of hourly and sector passage data were defined by the early, early middle, late middle and late strata for age-sex-size sampling goals. Each terminal stratum was defined by an approximate 2-week interval with the two middle strata defined by a 1-week period: June 16 - June 30; July 1 - 7; July 8 - 15 and July 16 - 30. These strata were determined preseason, based on historic run timing data, in an attempt to sample the escapement in proportion to the total run.

Water depth profile at each bank-specific sonar site was measured at 3 m intervals from established headpins across the width of the river by probing with a pole marked in 1 cm increments. River profile data was collected twice during the season. Climatological data were collected at approximately 1800 hours each day at the campsite. Relative river depth was monitored by staff gauge marked in 0.01 ft increments. Change in water depth was converted to cm and presented as negative or positive increments from the initial reading of 0.0 cm. Water temperature was measured in degrees centigrade near shore at a depth of about 0.5 m. Daily maximum and minimum air temperatures were recorded in degrees centigrade. Subjective notes were kept by the crew describing wind speed and direction, cloud cover, and precipitation.

A beach seine (100 ft long, 66 meshes deep, 2.5 in mesh) was set near the sonar site to capture chum and chinook salmon for age, sex, and size measurements. All captured salmon were enumerated by species and sex. Chum and chinook salmon were placed in a holding pen, identified by sex, and measured from mid-eye to fork of tail in mm. One scale was taken for age determination from chum salmon. Three scales were taken from each chinook salmon sampled for determination of age and stock-of-origin analysis. Scales were removed from an area posterior to the base of the dorsal fin and above the lateral line on the left side of the fish. The adipose fin was clipped on each fish before release to prevent resampling. Additionally, chinook salmon carcasses were sampled in August to supplement the beach seine sample. Scale samples were later pressed on acetate cards and the resulting impressions viewed on a microfiche reader for age determination. Sample size goals were based on 95% precision with a 10% accuracy for each time stratum. A sample size of 150 fish per stratum (early, early middle, late middle, and late) was needed for chum salmon. This sample size accounts for a 15% unageable rate when 1 scale per fish is collected. A sample size of 400 chinook salmon per stratum (entire season) was deemed necessary for the scale-pattern analysis baseline for the Anvik River stock. The maximum sample size needed to describe the age composition of the chinook salmon population of the Anvik River, considering only one stratum, with 95% precision and 10% accuracy is 150.

RESULTS AND DISCUSSION

Two sonar counters were operated on the Anvik River from June 21 through July 29 at the same sites used in previous years (Figure 2). The east bank transducer was located along a cutbank approximately 150 m above the field camp site. Initial placement of the east bank transducer was approximately 1.0 m offshore and at a depth of 50 cm. The west bank transducer was located along a gradually sloping gravel bar, approximately 60 m downstream from the east bank site. Initial placement of the west bank transducer was approximately 9.0 m offshore and at a depth of 25 cm. Due to river level fluctuations offshore placement of the transducer as well as water depth at the transducer varied throughout the season. However, due to the low water experienced on the Anvik River during the 1990 season only a small portion, less than 10 m, of the central river channel was not insonified on June 27 and July 18 (Figures 3 and 4). Similar river insonification was achieved during the initial placement of the transducers on June 21 and throughout the season. River transect data collected on June 27 and July 18 indicates that the bottom gradient was relatively smooth on the west bank, with no major obstructions to the sonar beam (Figure 3). Bottom gradient of the east bank was smooth for the first 9 m to the bottom of a trough (Figure 4). Although the ridge which existed beyond the trough appears to be a major obstruction to the sonar beam (Figure 4), the actual obstruction did not interfere with salmon counts. The discrepancy between the actual versus the observed obstruction can be explained by the placement of the river profile transect in relation to the insonified zone. River transect data was collected approximately 20 m upstream of the sonar beam where the relief of the trough was more acute than within the insonified zone. Additionally, the rock-inhibiting feature on the 1981-model sonar counters eliminated the remaining obstruction from the counting range of the insonified zone.

River width data collected in conjunction with the transect profiles varied from a high on June 27 at the east and west bank sonar sites of approximately 66 m and 63 m, respectively, to 63 m and 57 m, respectively, on July 18. Maximum river depth observed during the collection of river profile data was 135 cm recorded on June 27 within the east bank transect profile. Overall maximum river width and river depth during the field season most likely occurred during the first full day of field operations, June 21. River water level dropped approximately 43 cm between June 22 and July 8 (Figure 5) in a fairly consistent and regular manner. However, heavy rains in mid-July caused a dramatic increase in river level of approximately 40 cm in three days. This freshet temporarily disrupted sonar counting operations on July 10. Water temperature ranged from a low of 10 C on June 22 to a high of 20 C on July 1, while air temperature ranged from a low daily minimum of 4 C on July 7 and 11 to a high daily maximum of 30 C observed on July 21 (Figure 5).

The adjusted escapement count for the period June 21 through July 29 was 403,627 summer chum salmon (Table 1). As in 1988 and 1989, the four-day period June 29 through July 2 accounted for the greatest salmon passage, 23%. Information concerning escapement timing was mixed. The mean day of passage, July 8 (SD = 8.72), indicated an average run timing (Figure 6), while the median day of passage, July 6, indicated an earlier run timing. However, comparison of the 1990 run timing with the overall mean run timing (Figure 7) indicates that the first three quartiles of the run were early, while the last quartile was late. Therefore, it appears that the median day of the 1990 escapement passage is the better indicator of the central estimate of run timing. Run timing data collected for the 1986 run were excluded from the calculation of the mean run timing curve because data collection in 1986 was terminated prior to the end of the run.

Although the pre-season expectation for 1990 was for an above-average summer chum salmon return, in-season assessment indicated that the run was below average in abundance. In response, commercial fishing time with restricted-mesh-size gill nets was severely restricted in the lower Yukon River management area during the summer season. Only one fishing period with restricted mesh size was allowed in District 1, two were allowed in District 2, and none were allowed in District 3. Commercial fishing time in these districts with restricted mesh size gill nets totaled 18 h for the 1990 season.

Buklis (1982a) expanded the season escapement estimates for 1972 through 1978, making it possible to more directly compare visual count estimates to more recent annual sonar count estimates (Figure 8). The 1990 escapement estimate of 403,627 summer chum salmon was 63% less than the parent year escapement in 1986, was approximately 17% below the escapement objective of 487,000 fish, and was also 38% below the long term (1972-1989) average of 646,500 fish. Additionally indicative of a below average return, the 1990 District 1, 2, and 3 commercial harvest of 282,061 summer chum salmon was the lowest since 1972 and 60% below the 1985-1989 average.

A total of 47.01 hours of sonar calibration were conducted over a 38-day period at the west bank site. Sonar accuracy (sonar count/oscilloscope count) averaged 1.03 (Table 2). Sonar accuracy averaged 1.06 for 47.05 hours of oscilloscope calibration at the east bank site over the same period (Table 2).

Temporal distribution of the west and east bank adjusted sonar counts by hour (Appendix A.1 and A.2, respectively) indicates a distinct diel pattern of salmon passage (Figure 9). Based upon adjusted counts salmon passage was lowest during the hours ending 0700-1600 (averaging 2.9% of total daily passage per hour) and greatest during 2000-0400 (averaging 5.5% of total daily passage per hour). This pattern was relatively consistent throughout the season (Figure 10) and very similar to the 1988 and 1989 temporal distribution pattern of the migration (Sandone 1989, 1990).

Spatial distribution of the adjusted sonar counts by sector (Figure 9) indicates that most of the salmon passage occurred near shore on the west bank, sonar sectors 2, 3, and 4 (Appendix A.3). Most of the salmon passage associated with the east bank also occurred in the sonar sectors near shore, sectors number 28, 29, and 30 (Appendix A.4). The sonar sectors nearest the shoreline of each bank, sonar sectors 1 (west bank) and 31 and 32 (east bank) were low probably due to the salmon avoiding the nearby weir and transducer. Overall, over 76% of the total adjusted sonar counts were associated with the west bank. West bank sectors 2 through 4 accounted for 59% of all adjusted sonar counts, while east bank sectors 28 through 30 accounted for 12%. The remaining 29% of the counts were distributed across the other 26 sonar counting sectors. These percent passage rates are remarkably similar to passage rates observed for similar sectors for the 1989 escapement migration (Sandone 1990). This spatial distribution varied little throughout the season (Figure 11).

Twenty-four (24) beach seine sets were made from June 25 to July 28. A total of 428 chum salmon were captured (Appendix A.5). However, individual strata sampling goals were not achieved. The low water level of the Anvik River in 1990, in conjunction with the low numbers of salmon present, hampered sampling efforts throughout the field season. Stratum sampling sizes were 61, 135, 96, and 136 for the four sampling strata. Therefore, stated levels of precision and accuracy for age and sex composition of summer chum salmon were not achieved for individual stratum estimates. Of the 428 chum salmon sampled for age-sex-size data, 399 (93%) later proved to have ageable scales. Age and sex composition of the escapement passing the sonar site varied through time in a fairly consistent manner (Figure 12). However, age-4 chum salmon dominated all sampling stratum. Age composition of the escapement, weighted by strata escapement counts, was 3.2% age 3, 65.1% age 4, 30.1% age 5, and 1.6% age 6 (Appendix A.6). Age-5 chum salmon dominated the escapement in 1972, 1976, 1981, 1986, and 1989, but in all other years since 1972 the 4-year-old age class has dominated (Figure 13). Male chum salmon dominated during the first stratum. Female chum salmon dominated during the last stratum. Overall, female chum salmon accounted for 51.3% of the 1990 escapement to the Anvik River. Females have contributed more than 50% to the escapement sample of summer chum salmon in 16 of the 19 years of record. No chinook or pink salmon were captured by beach seine. However, 456 chinook salmon carcass samples were collected by boat survey in August.

Parent year escapements to the Anvik River in 1985 and 1986 were in excess of 1,000,000 salmon. However, returns from these escapements were very disappointing. The highest possible production rate, in terms of return per spawner, for the 1985 year class is 1.1. This maximum return per spawner was calculated based on the assumption that all summer chum salmon harvested downstream of the mouth of the Anvik River, plus the number of salmon associated with the District 4A commercial harvest which were delivered to Anvik-based processors, were destined for the Anvik River. Sandone (*in press*) estimated that 31% of the District 4A total harvest was delivered to Anvik-based processors in 1989. Likewise, based on the above-stated assumption and estimated age-3, age-4 and anticipated age-5 returns, the total maximum return per spawner for the 1986 year class is expected to be less than 1.0. Since these estimates of productivity are maximums, there appears to have been a failure in the productivity of these two year classes. This failure indicates that a spawning escapement of one million summer chum salmon in the Anvik River may be detrimental to the production of this stock. However, more study is needed to ascertain the optimal spawning escapement objective of the Anvik River summer chum salmon stock.

Unlike previous years, age and sex composition of the 1990 District 1 commercial catch of summer chum did not substantially vary by mesh size or progression of the run. Additionally, unlike previous years, the age composition of the District 1 commercial catch and Anvik River escapement samples were dissimilar in 1990. The age-class composition of the escapement was dominated by age-4 summer chum salmon, while the District 1 harvest was dominated by age-5 salmon. The preliminary age-class composition estimate of the total District 1 summer chum salmon harvest was 0.3% age 3, 34.2% age 4, 62.6% age 5, and 2.9% age 6 (D.

Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication). Similar to previous years, however, the sex composition of the 1990 Anvik River summer chum salmon escapement was dominated by females, while the District 1 commercial catch was dominated by males. Male chum salmon accounted for 55.8% of the District 1 harvest (D.Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication). The difference in the age and sex composition between the 1990 District 1 harvest and Anvik River escapement is thought to have occurred because of the selective nature of the large-mesh gill nets almost exclusively used in the lower river fisheries during the 1990 summer season, the increased susceptibility of the larger-sized male chum salmon to capture, and the timing of the lone small-mesh District 1 commercial fishing period. The only small-mesh fishing period allowed in District 1 occurred during the early portion of the run when age-5, male, summer chum salmon were thought to be present in a larger proportion.

Of the 456 chinook salmon sampled for age-sex-size data, 400 (88%) proved to have ageable scales. Age composition was 0.2% age 3, 26.3% age 4, 26.0% age 5, 43.8% age 6, and 3.8% age 7 (Figure 14). Females accounted for 37.0% of the sample (Appendix A.7). This percentage of females was less than the 40.3% long-term (1972-1989) average percent composition of females in escapement samples from the Anvik River. Age composition of the District 1 commercial harvest was approximately 12.9% age 4, 24.0% age 5, 55.7% age 6, 7.4% age 7, and 0.1% age 8. Female chinook salmon accounted for 44.2% of the harvest (D. Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication). As evidenced by the 1990 statistics, the District 1 commercial catch and Anvik River escapement age composition samples of chinook salmon are usually quite dissimilar. This difference is most likely due to the proportion of the various chinook stocks present in the lower river during the harvest period, and secondarily, to the size-selective nature of the commercial gill nets.

An aerial survey of the Anvik River (including Beaver Creek, Swift River, Canyon Creek, Otter Creek, and McDonald River) was flown on July 20 under good survey conditions. A total of 2,347 chinook salmon were enumerated. The count of 1,595 chinook salmon in the mainstem Anvik River between the Yellow River and McDonald Creek exceeded the minimum aerial survey count objective of 500 chinook salmon for this index area, and was the highest chinook salmon count ever recorded for this index area. A total of 68,340 chum salmon were also enumerated.

CONCLUSIONS AND RECOMMENDATIONS

Escapement to the Anvik River estimated by side-scanning sonar was 403,627 summer chum salmon in 1990. Although the pre-season outlook for the 1990 summer chum run was for an above-average return, the apparent production failure of the 1985 and 1986 year classes resulted in a very poor 1990 return. Accurate in-season assessment of run size resulted in conservative management of the commercial summer chum salmon fishery in the lower Yukon River. However, even with these restrictions, the escapement objective of 487,000 fish for the Anvik River was not achieved.

A record index area count of chinook salmon was observed during an aerial survey under good conditions. However, the quality of the escapement, in terms of percent females, was below the long-term average. The high percentage of 4-year-old chinook salmon in the spawning escapement, however, may indicate a strong future return from the 1986 year class in 1991 and 1992 as age-5 and -6 salmon.

Summer chum salmon run timing at the lower Yukon River set gill net test fishery (mile 20), at the Yukon River sonar site (mile 123), and at the Anvik River sonar site (mile 365) can be compared to provide a qualitative assessment of summer chum salmon timing through the lower river fisheries (Figure 15). The respective mean dates of passage at each of these three sites in 1990 was June 26, June 28, and July 8. Based on these data, the calculated lag time between the lower river test fishery and the Yukon River sonar passage in 1990 was 2 days. This lag time corresponds well with the accepted 2 to 3 day salmon migration time between the test fishery and the Yukon sonar site. It is interesting to note, however, that the median day of passage, the day on which 50% of the catch per unit effort (CPUE) or run passed, is one day earlier for the sonar than the test fish site. Since the sonar is approximately 103 miles upriver of the test fish site, this discrepancy indicates that a large number of fish, detected by the test fishing operations, may not have passed the sonar site. Because the mouth of the Andreafsky River is downriver of the sonar site, this explanation is plausible. Another explanation is that a larger portion of the harvest below the sonar site occurred prior to the median dates. In 1990 over 76%, or 214,465 salmon, of the District 1 and 2 harvest occurred prior to the median dates of the lower Yukon test fishery and the Yukon sonar site, respectively. This disproportional removal during the first half of the migration tended to shift the median date of the Yukon sonar passage earlier. This apparent discrepancy may also be partially explained by variable daily test net efficiency and sonar counts.

Based on mean day of salmon passage and the 345-mile distance from the Yukon River test fish site to the Anvik River sonar site, the calculated mean swimming speed of Anvik River chum salmon was 28.8 miles per day (mpd) in 1990. This swimming speed was 8.5, 4.2, and 7.2 mpd faster than in 1987 (Buklis 1987), 1988 (Sandone 1989), and 1989 (Sandone 1990), respectively. However, the annual swimming speed between the Yukon River sonar site and the Anvik River sonar site for Anvik River-destined summer chum salmon is less variable. Although the 1987 swimming speed was 34.6 mpd, calculated from mean day data presented by Buklis (1987), the migration time between the two sonar sites has been a consistent 10 days, or a swimming speed of 24.2 for years 1988-1990. The high swimming speed calculated for 1987 may be explained by an inaccurate sonar count for summer chum salmon at the Yukon River site, especially in the first half of the run. Problems with unstable river conditions at the Yukon sonar site in 1987 may have resulted in inaccurate count data (D. Mesiar, Alaska Department of Fish and Game, Anchorage, personal communication), thereby affecting the calculation of the mean day of passage. Using the median day of passage, however, the migration time between the two sonar sites has been 8, 9, and 9 days for 1988-1990. Corresponding swimming speeds varied from 26.9 to 30.3 mpd.

The method of deploying sonar transducers on the Anvik River, first used in 1986, was once again effective in 1990. The method should perform well even in very high water conditions, as were encountered in 1985. The schedule of sonar calibration times at the Anvik River was altered in 1989, and continued in 1990, to reflect the need for more sonar calibrations during times of peak salmon passage. Additionally, daily adjustment factors were replaced with period adjustment factors based on the time schedule of sonar calibrations. Period adjustment factors, based on the diel pattern of salmon movement, are more specific to a discrete set of sonar counts, and probably improve the accuracy of the daily estimate.

The addition of a third crew member on the Anvik River sonar project in 1989, and continued in 1990, resulted in improved project data quality, provided for better employee working conditions, and facilitated project logistics. The additional cost to the project was insignificant because the expansion of the crew to three people negated the need for overtime.

Because of the improvement in working conditions and quality of data collected, all recommendations suggested by Sandone (1989) which were initially implemented during the 1989 season should continue. Additionally, because the crew is working with 16-sector sonar counters rather than the 12-sector counter, the amount of calculations necessary to derive the daily passage estimate has increased by at least 33%. Therefore, to reduce the time spent generating the daily estimate, the use of a portable computer was initiated in 1990. The inseason use of a computer not only reduced the computational time for the crew but also aided in providing better quality data, provided the opportunity for crew members to become computer literate, and facilitated post season analysis of project data. If available, it is highly recommended that a portable computer be assigned to the Anvik sonar project on a continuing basis.

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Table 1. Anvik River summer chum salmon sonar counts by date, 1990.

	West Bank				East Bank				Entire River			
Date	Raw Daily	Adjust Factor[a]	Correct Daily	Percent of Daily Total	Raw Daily	Adjust Factor[a]	Correct Daily	Percent of Daily Total	Daily Count	Season Count	Daily Prop.	Season Prop.
21-Jun	95	1.38[b]	131	82.9	33	0.81[b]	27	17.1	158	158	0.0004	0.0004
22-Jun	788	1.38[b]	1,089	71.9	527	0.81[b]	426	28.1	1,515	1,673	0.0038	0.0041
23-Jun	1,029	1.38[b]	1,422	88.7	224	0.81[b]	181	11.3	1,603	3,276	0.0040	0.0081
24-Jun	1,079	1.23	1,329	72.3	628	0.81[b]	509	27.7	1,838	5,114	0.0046	0.0127
25-Jun	6,892	0.97	6,688	90.1	902	0.81[b]	731	9.9	7,419	12,533	0.0184	0.0311
26-Jun	14,856	0.94	13,967	94.7	956	0.81[b]	775	5.3	14,742	27,275	0.0365	0.0676
27-Jun	5,149	0.89	4,607	79.0	1,509	0.81[b]	1,223	21.0	5,830	33,105	0.0144	0.0820
28-Jun	14,896	0.99	14,730	93.2	1,321	0.81[b]	1,070	6.8	15,800	48,905	0.0391	0.1212
29-Jun	18,504	1.02	18,948	95.1	1,196	0.81[b]	971	4.9	19,919	68,824	0.0494	0.1705
30-Jun	19,654	1.10	21,559	82.6	4,402	1.03	4,534	17.4	26,093	94,917	0.0646	0.2352
01-Jul	17,781	1.11	19,778	77.4	5,673	1.02	5,788	22.6	25,566	120,483	0.0633	0.2985
02-Jul	16,273	0.98	15,874	69.9	5,498	1.25	6,850	30.1	22,724	143,207	0.0563	0.3548
03-Jul	8,321	1.02	8,524	69.5	4,321	0.87	3,744	30.5	12,268	155,475	0.0304	0.3852
04-Jul	19,326	0.96	18,554	76.1	4,075[c]	0.96[d]	5,831[e]	23.9	24,385	179,860	0.0604	0.4456
05-Jul	15,722	0.97	15,226	90.6	1,630	0.96	1,573	9.4	16,799	196,659	0.0416	0.4872
06-Jul	11,028	0.92	10,158	84.7	1,746	1.05	1,829	15.3	11,987	208,646	0.0297	0.5169
07-Jul	11,163	0.90	9,998	85.7	1,662	1.01	1,671	14.3	11,669	220,315	0.0289	0.5458
08-Jul	9,827	0.96	9,466	76.2	2,824	1.05	2,953	23.8	12,419	232,734	0.0308	0.5766
09-Jul	7,277	0.93	6,745	60.2	4,366	1.02	4,452	39.8	11,197	243,931	0.0277	0.6043
10-Jul	11,230[f]	0.75[g]	18,290[h]	64.7	7,245[j]	0.78[k]	9,972[l]	35.3	28,262	272,193	0.0700	0.6744
11-Jul	13,343	0.80	10,648	75.6	4,813	0.72	3,443	24.4	14,091	286,284	0.0349	0.7093
12-Jul	5,861	0.94	5,516	89.4	786	0.83	654	10.6	6,170	292,454	0.0153	0.7246
13-Jul	4,550	0.95	4,314	88.5	682	0.82	558	11.5	4,872	297,326	0.0121	0.7366
14-Jul	3,492	0.90	3,148	89.1	470	0.82	387	10.9	3,535	300,861	0.0088	0.7454
15-Jul	4,154	1.05	4,360	76.9	1,093	1.20	1,313	23.1	5,673	306,534	0.0141	0.7594
16-Jul	8,910	0.97	8,661	76.0	2,812	0.97	2,733	24.0	11,394	317,928	0.0282	0.7877
17-Jul	5,626	1.02	5,731	78.5	1,573	1.00	1,573	21.5	7,304	325,232	0.0181	0.8058
18-Jul	5,103	0.99	5,040	66.9	2,061	1.21	2,495	33.1	7,535	332,767	0.0187	0.8244
19-Jul	7,702	0.98	7,564	69.0	3,774	0.90	3,406	31.0	10,970	343,737	0.0272	0.8516
20-Jul	8,841	0.94	8,332	81.1	2,318	0.84	1,948	18.9	10,280	354,017	0.0255	0.8771
21-Jul	8,382	0.98	8,253	69.8	3,798	0.94	3,566	30.2	11,819	365,836	0.0293	0.9064
22-Jul	5,747	1.09	6,248	58.2	4,602	0.98	4,491	41.8	10,739	376,575	0.0266	0.9330
23-Jul	5,207	1.10	5,741	53.8	4,824	1.02	4,921	46.2	10,662	387,237	0.0264	0.9594
24-Jul	1,785	0.94	1,687	49.6	2,381	0.72	1,716	50.4	3,403	390,640	0.0084	0.9678
25-Jul	1,927	1.11	2,133	58.2	1,717	0.89	1,530	41.8	3,663	394,303	0.0091	0.9769
26-Jul	1,788	1.01	1,800	56.6	1,653	0.84	1,381	43.4	3,181	397,484	0.0079	0.9848
27-Jul	1,438	1.13	1,626	59.7	1,264	0.87	1,098	40.3	2,724	400,208	0.0067	0.9915
28-Jul	1,651	0.92	1,523	68.7	1,101	0.63	693	31.3	2,216	402,424	0.0055	0.9970
29-Jul	1,145	1.00	1,145	95.2	58	1.00	58	4.8	1,203	403,627	0.0030	1.0000

[a] Adjustment factor is the ratio of the corrected daily sonar counts to the raw sonar counts.
[b] Sonar calibration data were pooled for June 21-23 for the west bank and June 21-29 for the east bank adjustment factor calculation due to the small number of fish counted during calibration periods on these days.
[c] Raw count data are for sectors 22-32; data unavailable for sectors 17-21.
[d] Pertains to sectors 22-32.
[e] Includes the estimated salmon count for sectors 17-21. This estimate was derived by dividing the corrected count for sectors 22-32 by the mean proportion of the east bank counts recorded for those sectors on July 3 and 5.
[f] Raw count data are for the period 1300 - 2400; data unavailable for the period 0000 - 1300.
[g] Pertains to the period 1300 - 2400.
[h] Includes the estimated salmon count for the period 0000 - 1300. This estimate was derived by dividing the corrected count for the period 1300-2400 by the mean proportion of the west bank counts recorded for that period on July 9 and 11.
[j] Raw count data are for the period 1300 - 2400; data unavailable for the period 0000 - 1300.
[k] Pertains to the period 1300 - 2400.
[l] Includes the estimated salmon count for the period 0000 - 1300. This estimate was derived by dividing the corrected count for the period 1300-2400 by the mean proportion of the east bank counts recorded for that period on July 9 and 11.

Table 2. Sonar and oscilloscope counts of salmon at the Anvik River west and east bank sites, 1990.

	West Bank Sonar Site				East Bank Sonar Site			
Date	Hours Count	Sonar Count	Scope Count	Sonar/ Scope	Hours Count	Sonar Count	Scope Count	Sonar/ Scope
22-Jun	0.75	0	0	0.00	0.67	0	0	0.00
23-Jun	1.00	0	0	0.00	0.33	0	0	0.00
24-Jun	1.25	56	82	0.68	0.83	0	0	0.00
25-Jun	1.38	536	562	0.95	1.25	2	2	1.00
26-Jun	1.58	548	586	0.94	1.50	8	3	2.67
27-Jun	1.25	179	158	1.13	1.05	12	12	1.00
28-Jun	1.37	442	430	1.03	1.38	13	11	1.18
29-Jun	1.47	766	754	1.02	1.55	8	7	1.14
30-Jun	1.35	527	559	0.94	1.32	15	13	1.15
01-Jul	0.88	374	436	0.86	1.63	239	250	0.96
02-Jul	0.95	391	380	1.03	1.33	106	123	0.86
03-Jul	1.00	179	179	1.00	1.67	185	167	1.11
04-Jul	0.25	45	41	1.10	0.25	0	0	0.00
05-Jul	1.65	568	542	1.05	1.17	63	58	1.09
06-Jul	1.10	351	322	1.09	1.42	50	51	0.98
07-Jul	1.20	229	209	1.10	1.68	71	80	0.89
08-Jul	1.23	323	293	1.10	1.50	44	46	0.96
09-Jul	1.08	176	165	1.07	1.03	11	12	0.92
10-Jul	0.88	307	231	1.33	0.58	58	56	1.04
11-Jul	1.78	285	218	1.31	2.82	204	154	1.32
12-Jul	0.92	446	336	1.33	1.00	11	9	1.22
13-Jul	1.25	384	358	1.07	1.25	3	4	0.75
14-Jul	1.67	213	230	0.93	1.25	1	1	1.00
15-Jul	1.50	218	257	0.85	1.20	19	23	0.83
16-Jul	1.50	304	291	1.04	1.25	73	71	1.03
17-Jul	1.41	216	223	0.97	1.30	50	50	1.00
18-Jul	1.33	173	169	1.02	1.42	15	29	0.52
19-Jul	1.08	321	313	1.03	1.50	101	91	1.11
20-Jul	1.33	325	299	1.09	1.42	70	60	1.17
21-Jul	1.68	410	409	1.00	0.92	22	21	1.05
22-Jul	1.48	258	291	0.89	1.58	57	56	1.02
23-Jul	1.42	160	132	1.21	1.25	137	125	1.10
24-Jul	1.25	105	100	1.05	1.25	40	26	1.54
25-Jul	1.42	82	93	0.88	1.58	12	10	1.20
26-Jul	1.25	87	88	0.99	0.75	21	18	1.17
27-Jul	1.00	38	45	0.84	1.17	43	37	1.16
28-Jul	1.12	82	74	1.11	1.25	25	16	1.56
29-Jul	1.00	30	26	1.15	0.75	2	2	1.00
Total	47.01	10,134	9,881	1.03	47.05	1,791	1,694	1.06

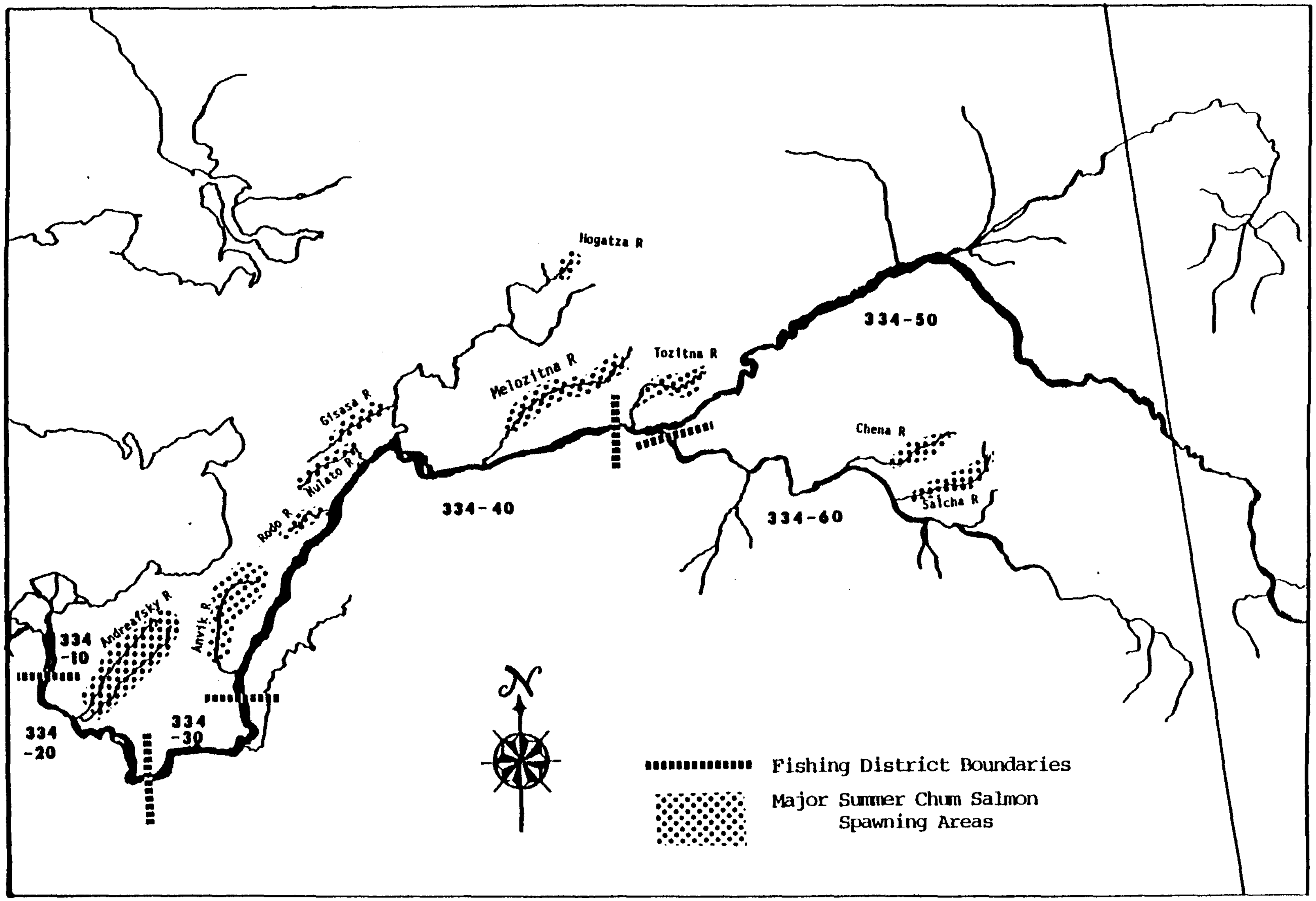


Figure 1. Map of Yukon River, showing fishing districts and major summer chum salmon spawning areas.

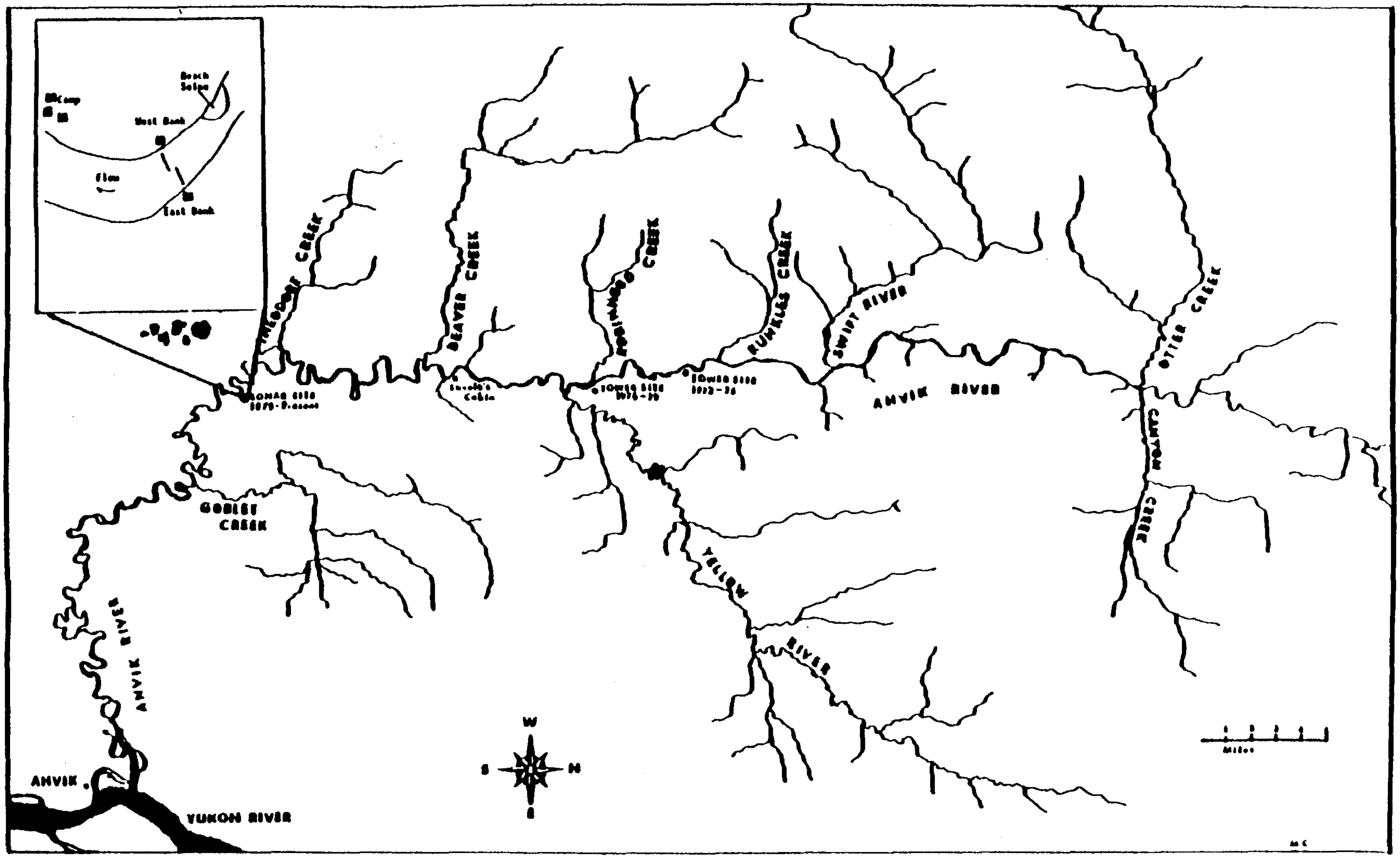


Figure 2. Map of the Anvik River with schematic sketch of the sonar site camp area (inset).

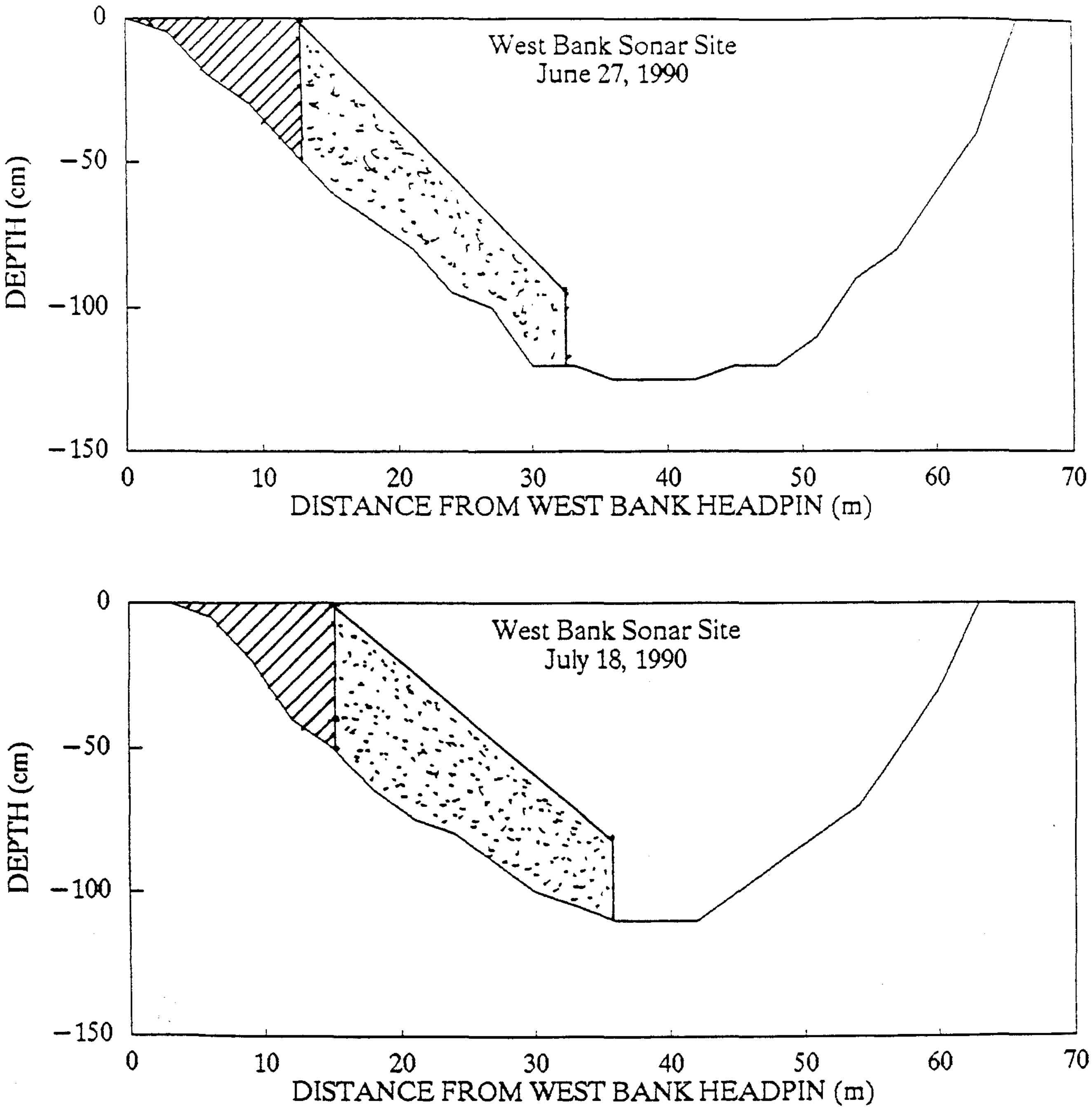
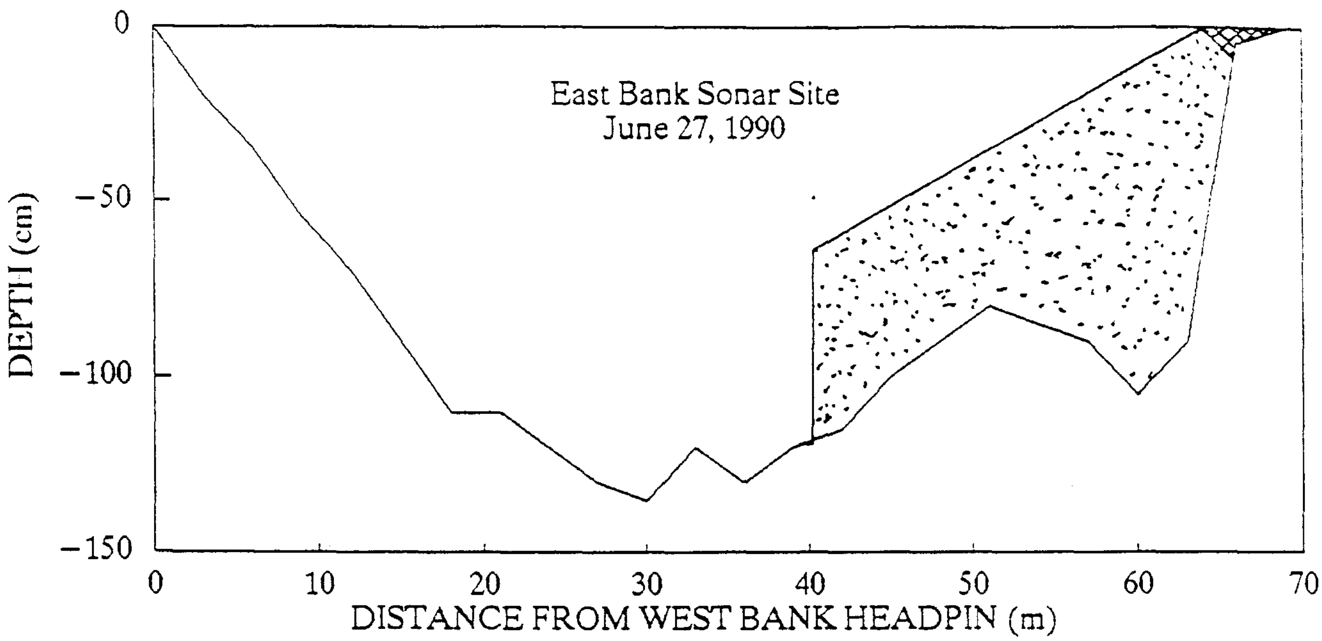


Figure 3. Anvik River depth profiles, west bank sonar site, June 27 and July 18, 1990. Stippled areas show approximate range of insonification. Weirs are indicated with cross hatching.



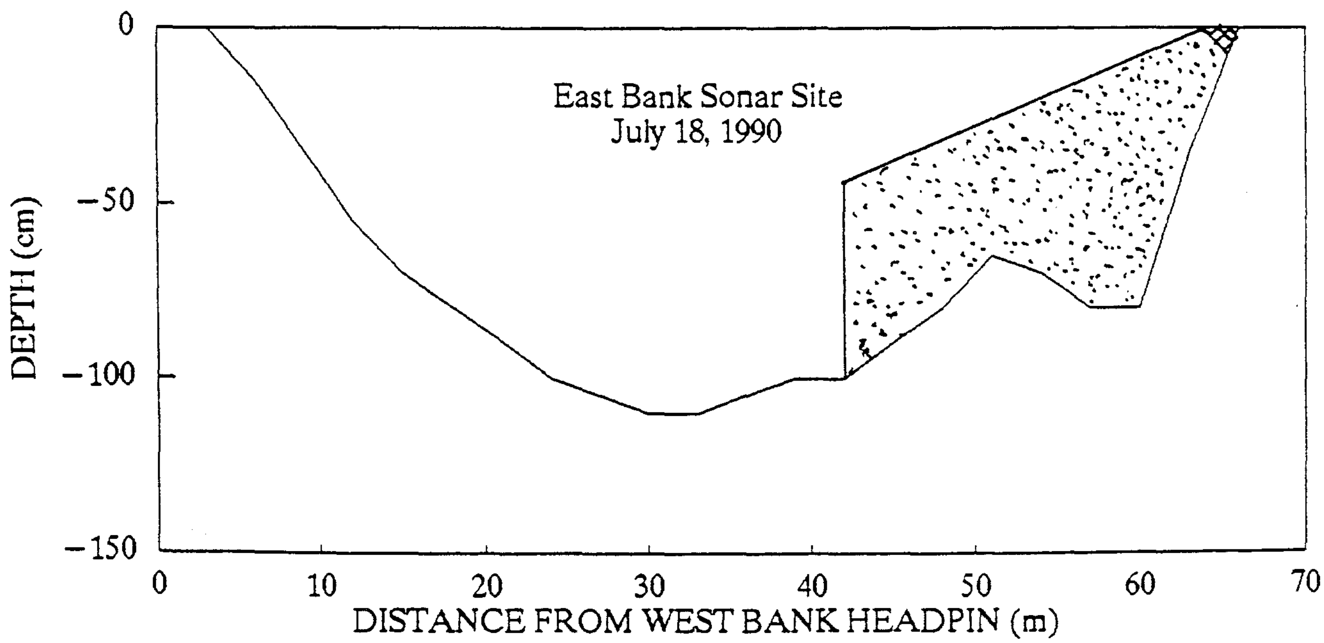


Figure 4. Anvik River depth profiles, east bank sonar site, June 27 and July 18, 1990. Stippled areas show approximate range of insonification. Weirs are indicated with cross hatching.

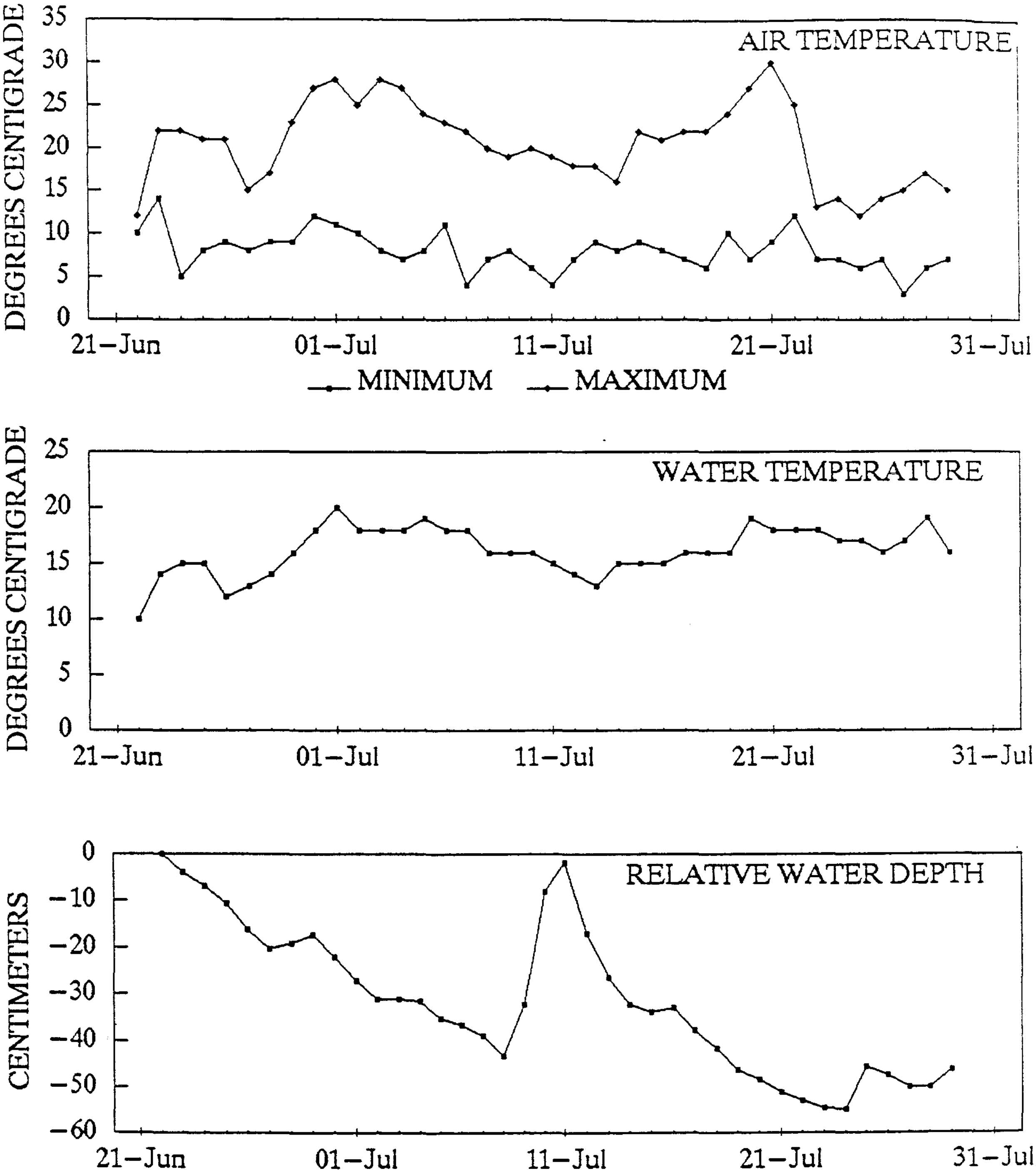


Figure 5. Daily minimum and maximum air temperatures, instantaneous water temperature, and relative water depth measured at approximately 1800 hours daily at the Anvik River sonar site, 1990.

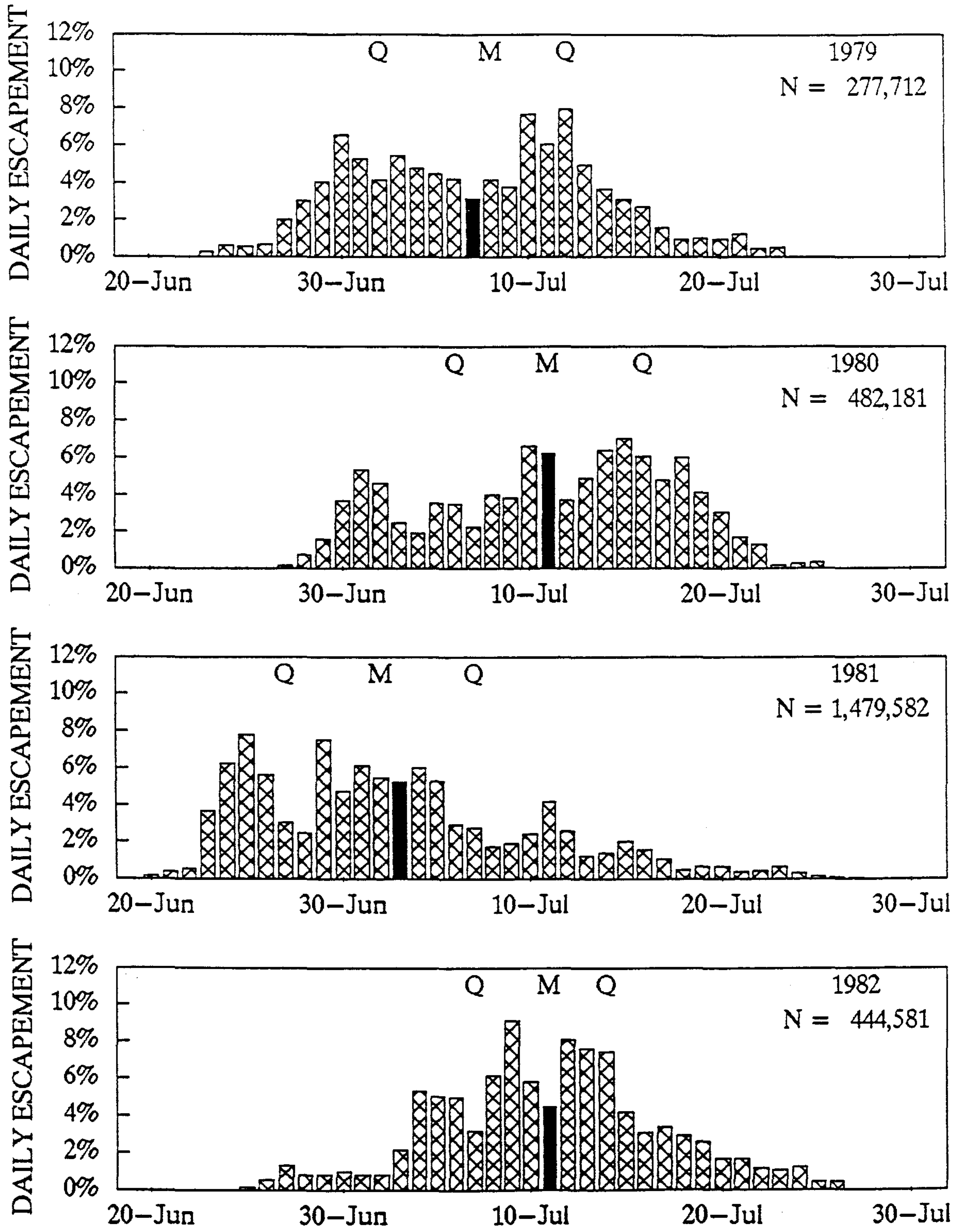


Figure 6. Daily proportion of corrected Anvik River sonar counts of summer chum salmon passage by day, 1979-1990 (N = total). Mean date of run passage is indicated by shaded bar. Quartile passage days are indicated by the "Q" (first and third), while the median day of passage is indicated by the "M".

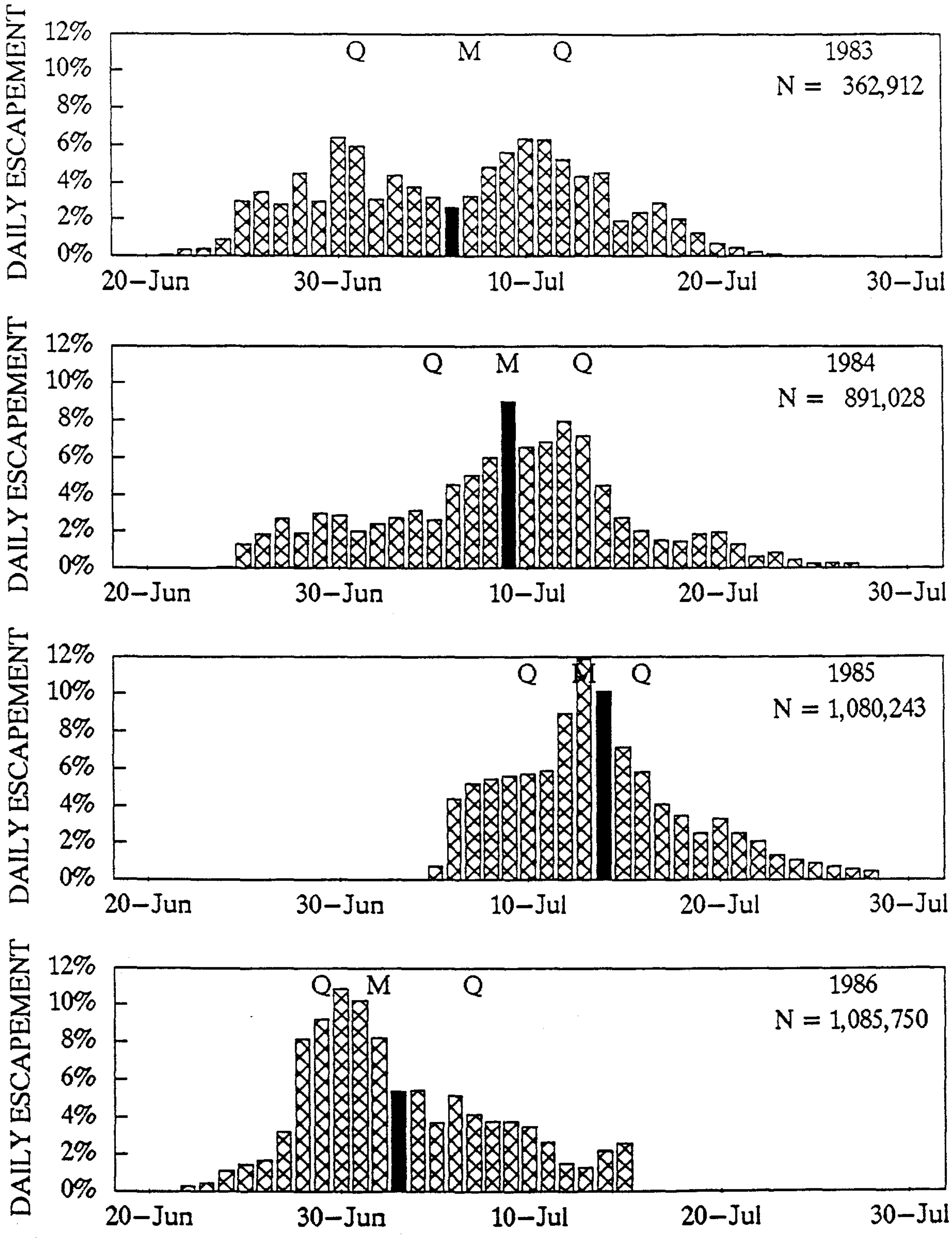


Figure 6. (page 2 of 3)

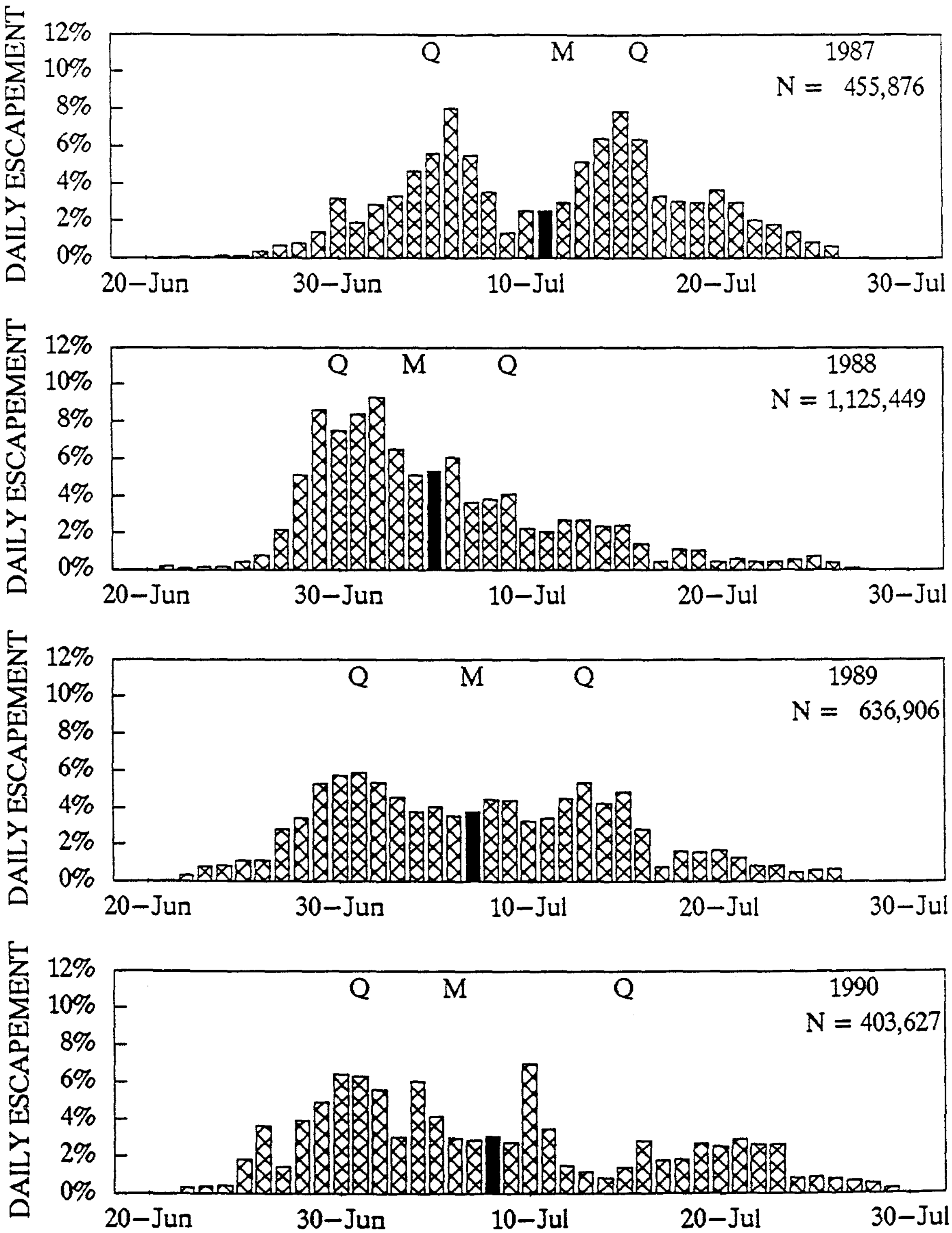


Figure 6. (page 3 of 3)

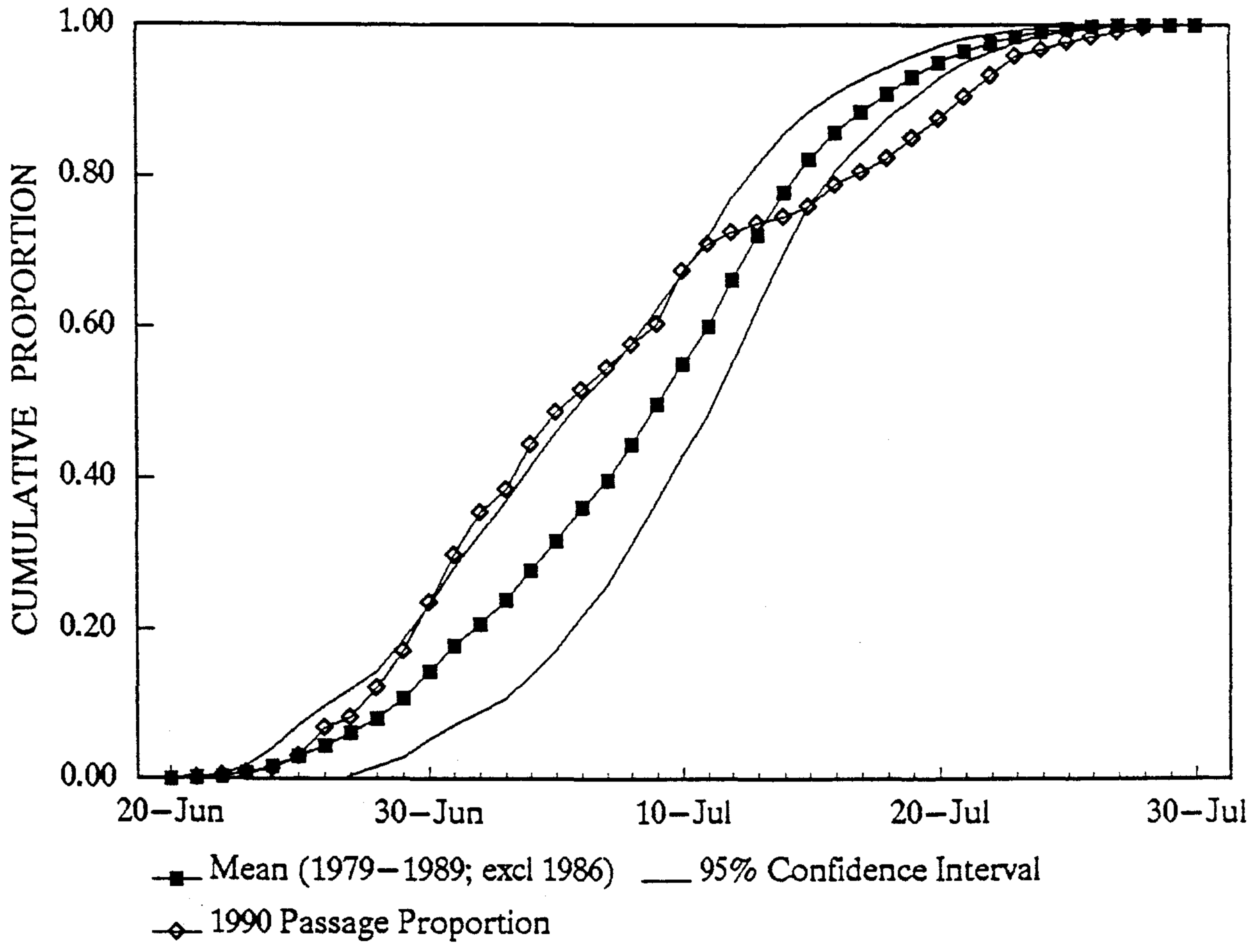


Figure 7. Mean (1979-1989; excl 1986) and 1990 run timing curves for Anvik River summer chum salmon.

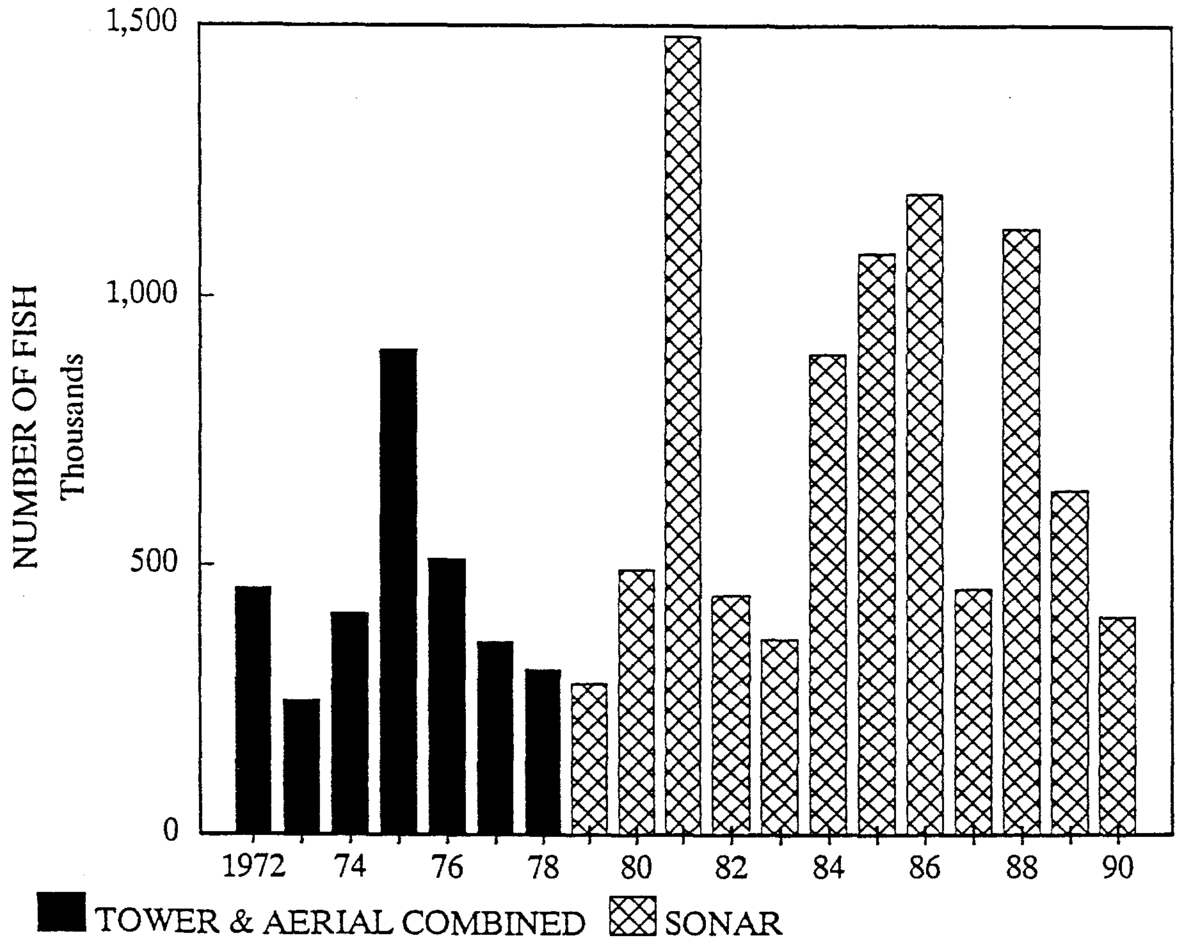


Figure 8. Anvik River summer chum salmon escapement estimated by combined tower and aerial survey count, 1972-1978, and by side-scanning sonar, 1979-1990.

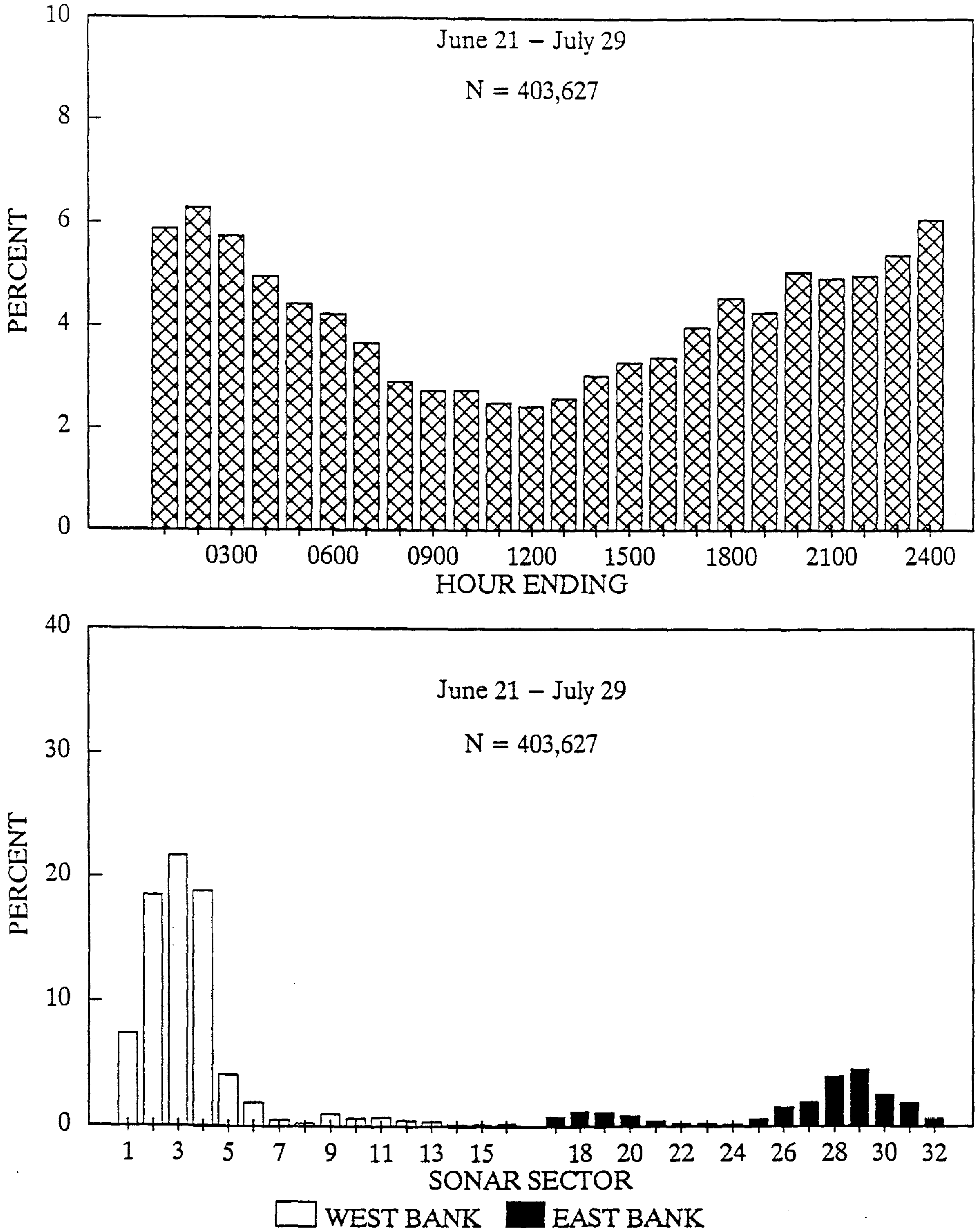


Figure 9. Corrected temporal (above) and spatial (below) sonar counts of summer chum salmon passage, Anvik River sonar site, 1990.

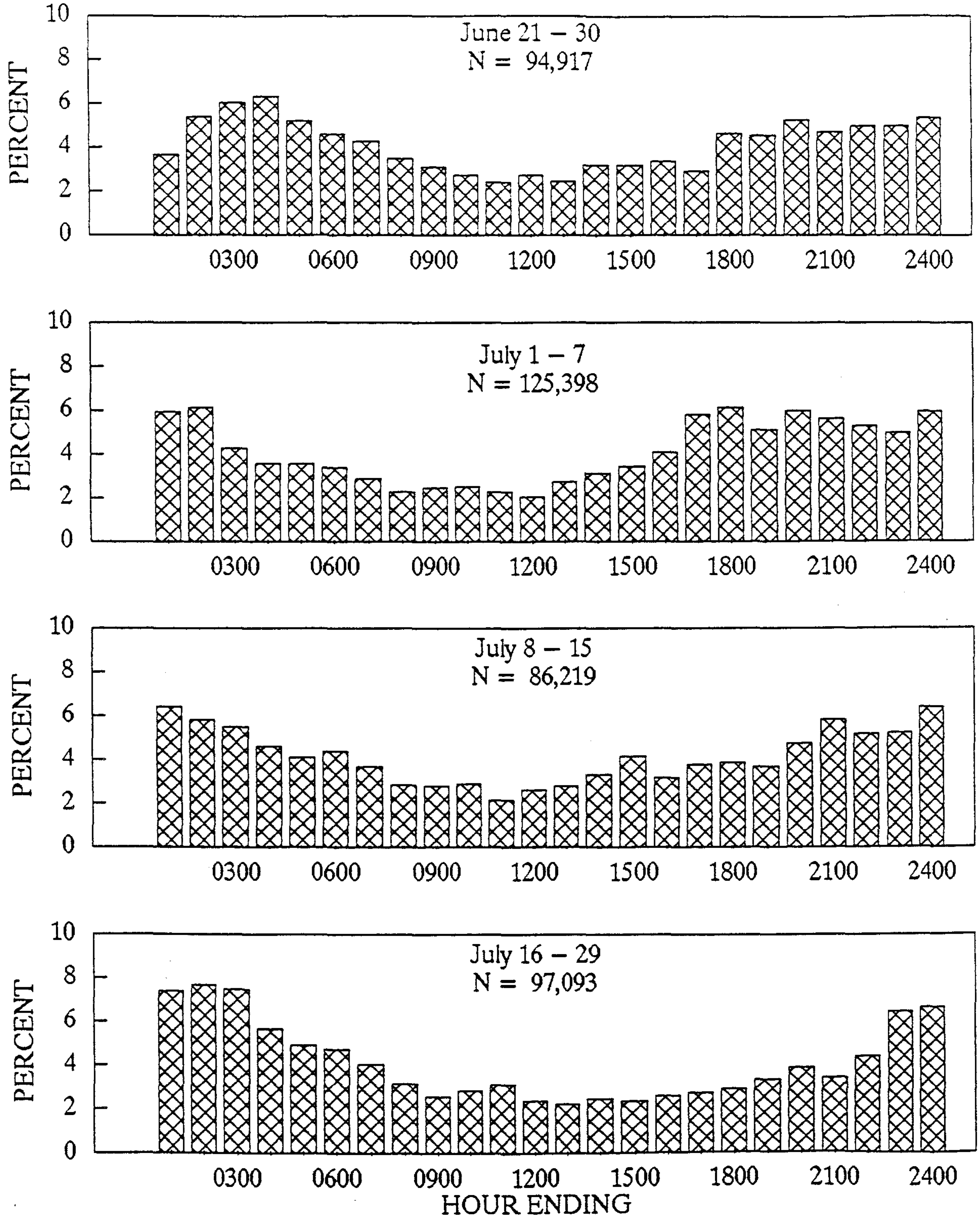


Figure 10. Anvik River corrected sonar counts of summer chum salmon passage by sampling stratum and hour of the day, 1990.

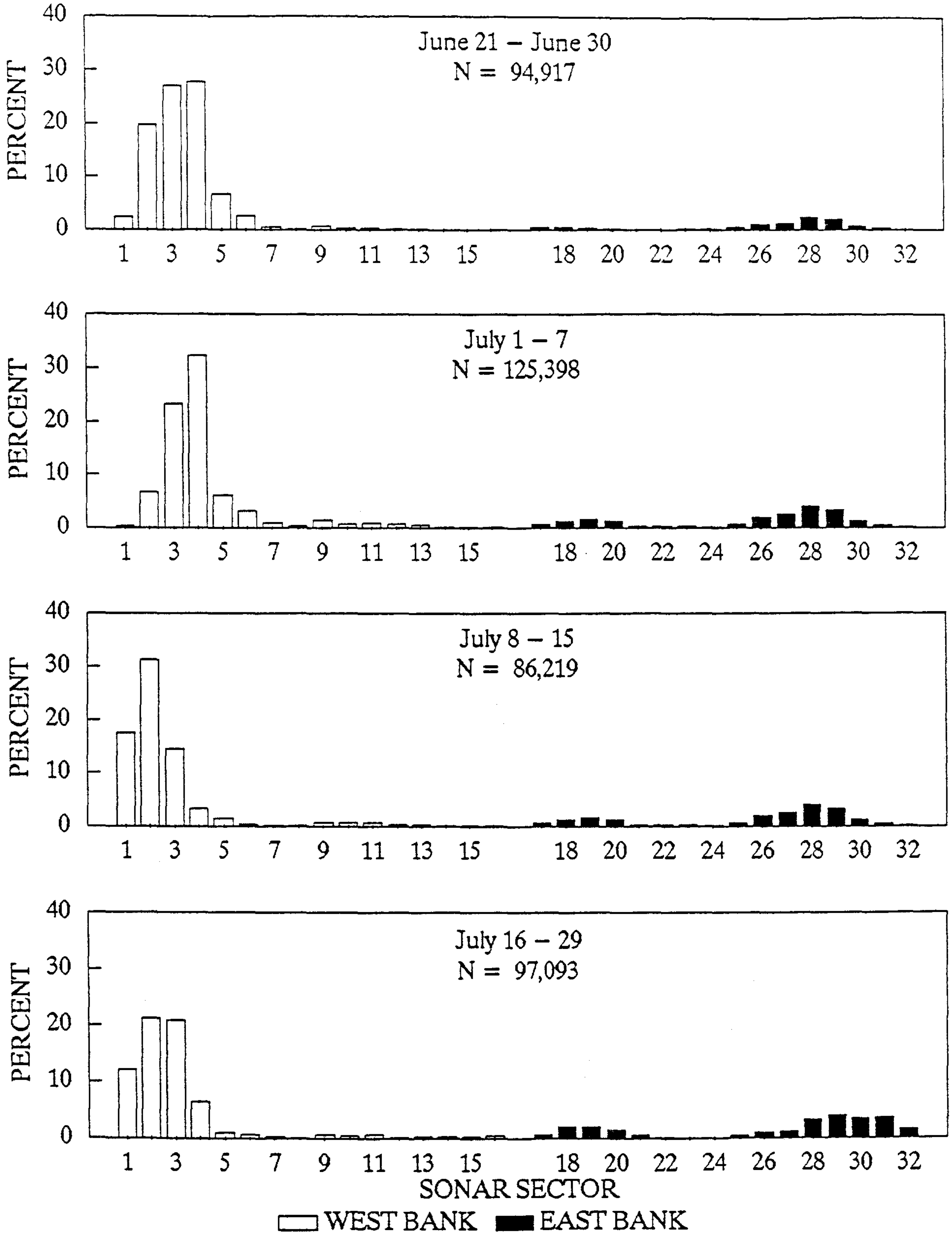


Figure 11. Anvik River corrected sonar counts of summer chum salmon passage by sampling stratum and sonar sector, 1990.

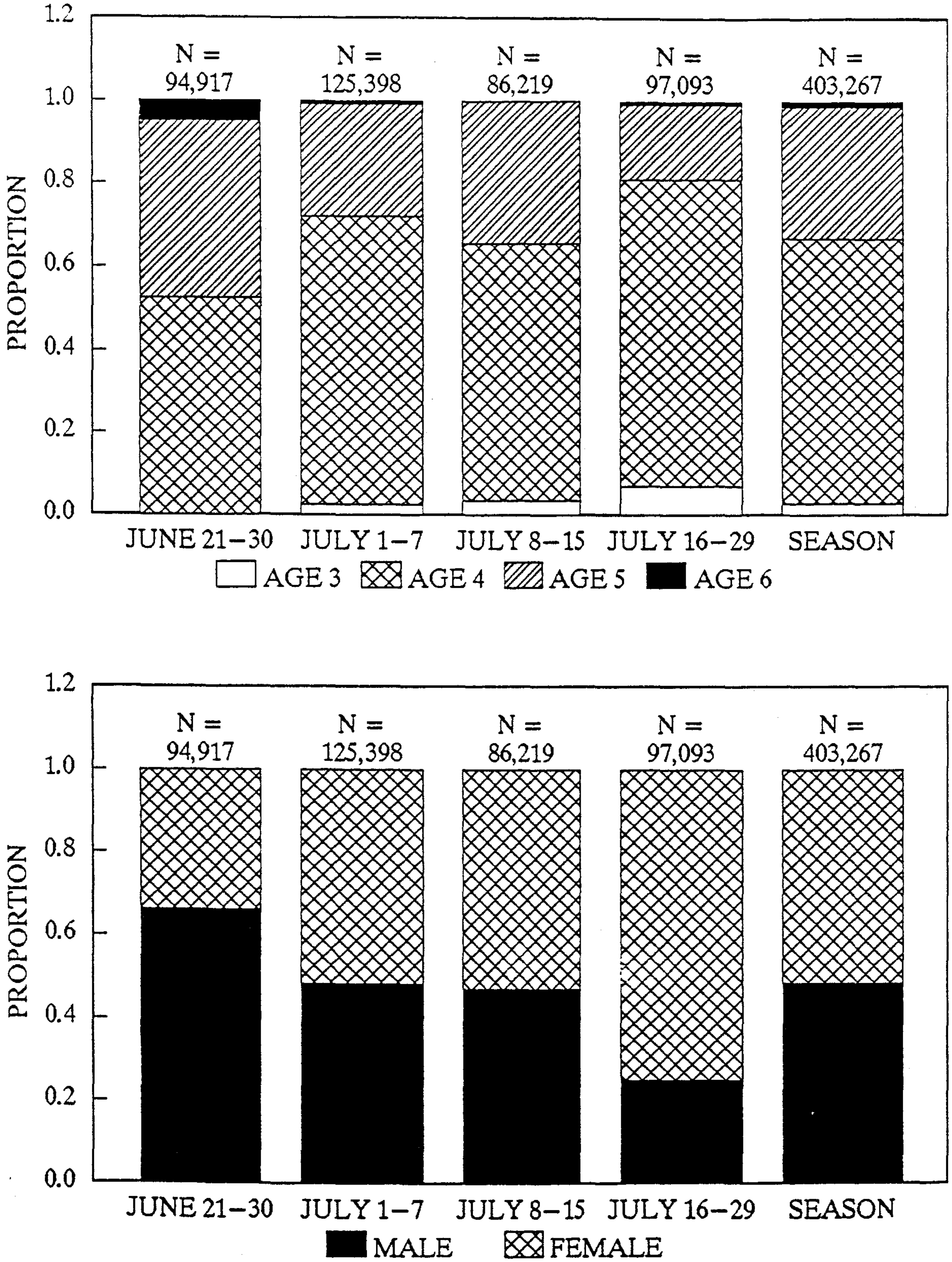


Figure 12. Age and sex composition of sampled Anvik River summer chum salmon by sampling stratum, 1990.

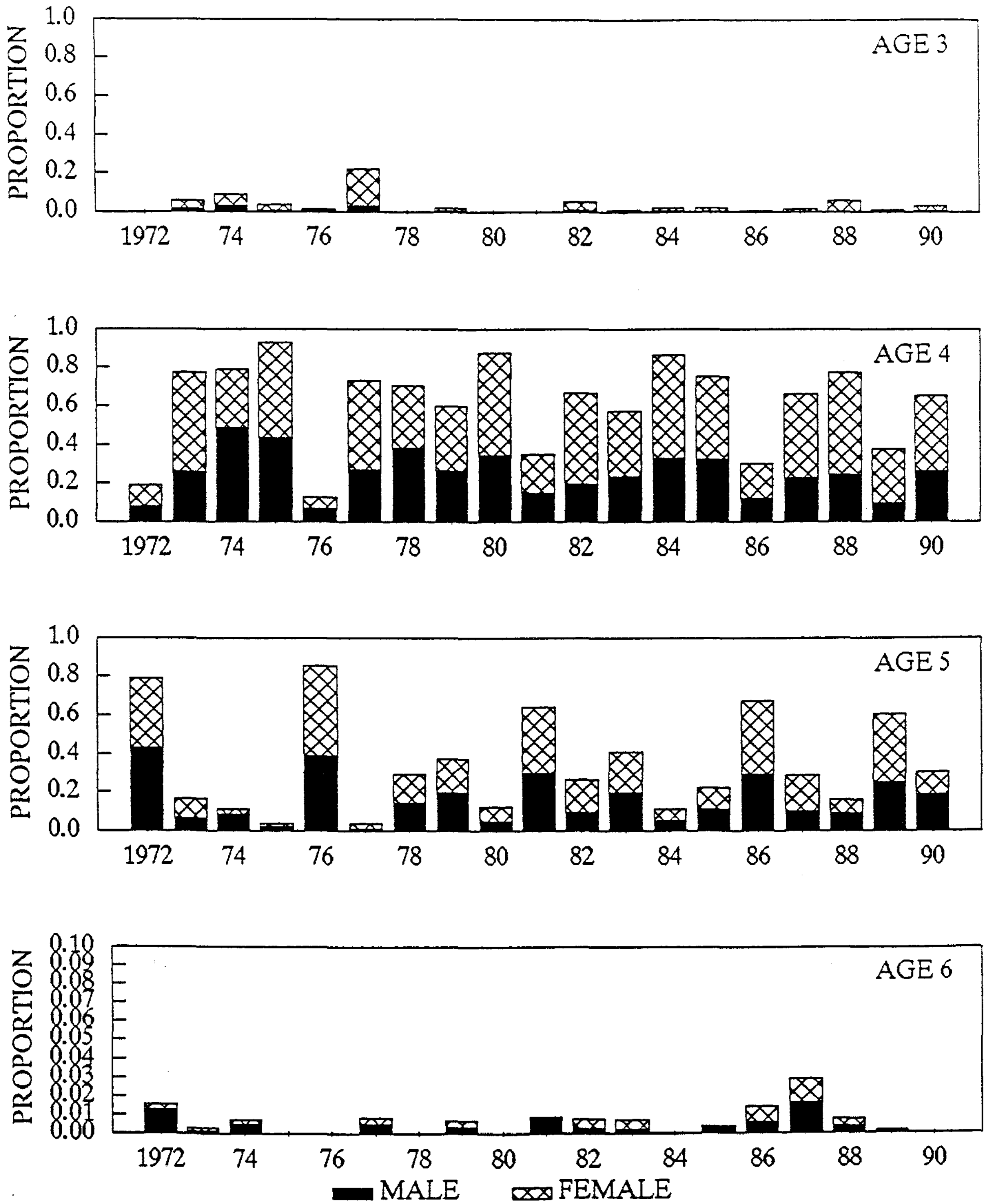


Figure 13. Age and sex composition of sampled Anvik River summer chum salmon, 1972-1990. (Note different Y-axis scale for age-6 salmon.)

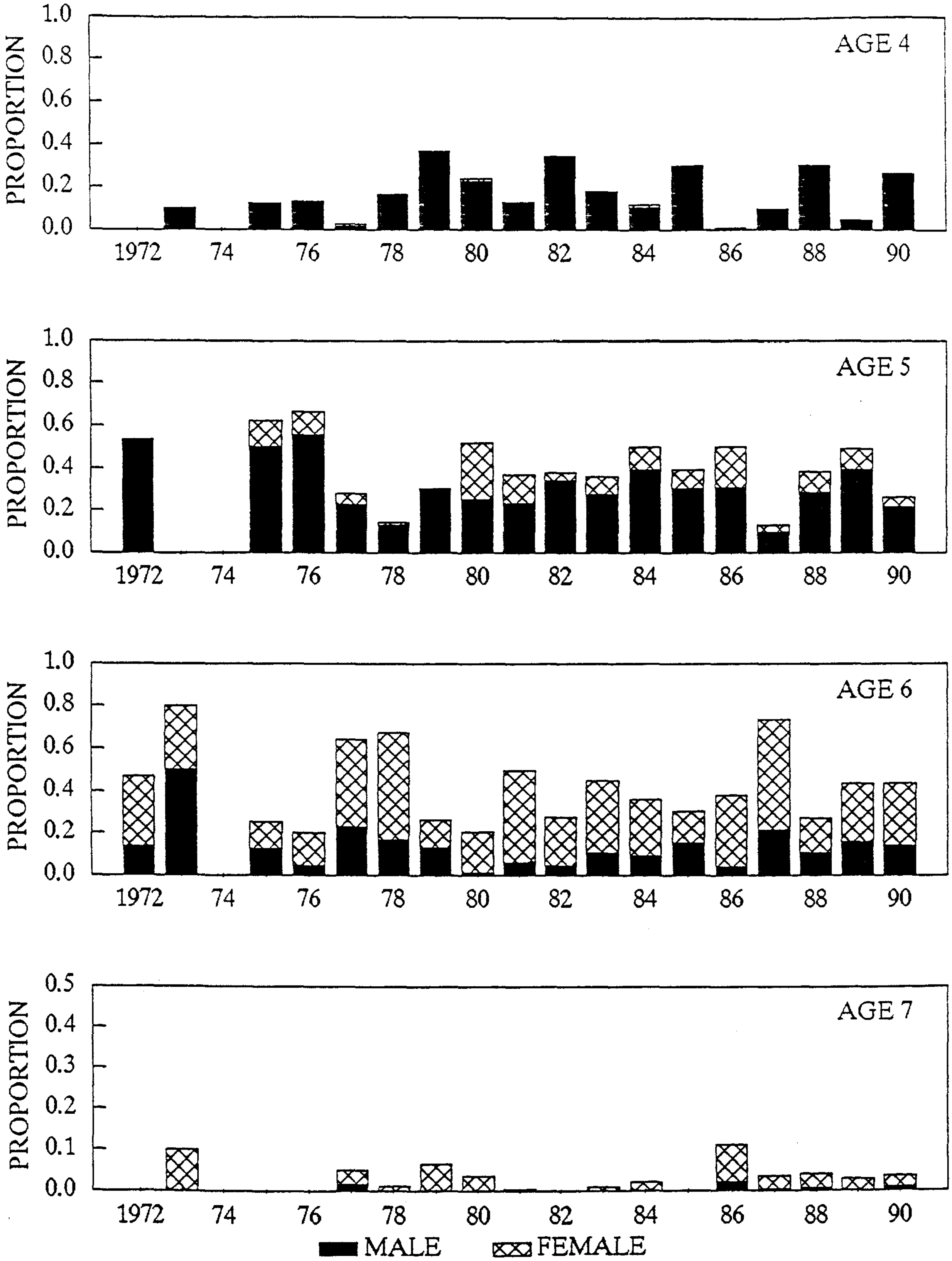


Figure 14. Age and sex composition of sampled Anvik River chinook salmon, 1972-1990. (Note different Y-axis scale for age-7 salmon.)

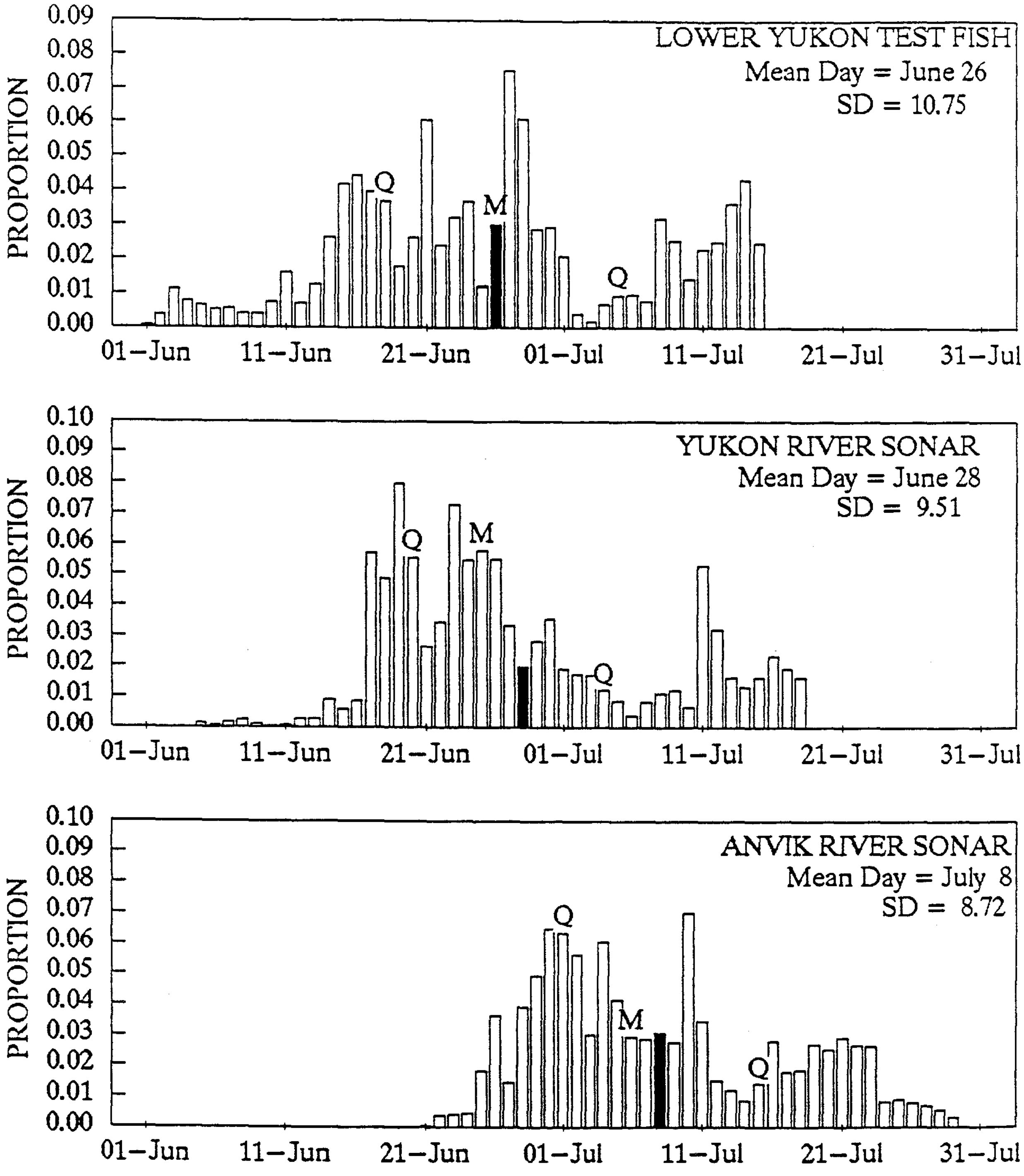


Figure 15. Run timing of Yukon River summer chum salmon in 1990 as indicated by test fish catches or sonar counts at three sites. Mean date of run passage is indicated by the shaded bar. Quartile passage days are indicated by the "Q" (first and third), while the median day of passage is indicated by the "M".

APPENDICES

Appendix A1. West bank Anvik River corrected sonar counts by hour and date, June 21 - July 29, 1990.

Hour End	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul	09-Jul
1	-	41	18	51	243	792	424	184	401	965	574	824	649	424	821	754	563	920	233
2	-	47	21	77	159	783	751	338	673	1,263	1,144	850	559	468	836	682	517	689	335
3	-	101	68	101	286	682	423	354	791	1,387	1,143	802	283	387	437	378	195	494	267
4	-	97	126	55	320	1,278	335	850	1,008	1,146	1,025	673	169	361	433	493	130	421	151
5	-	87	225	47	332	901	412	403	786	1,142	896	631	293	257	534	386	112	345	198
6	-	149	168	25	253	781	329	704	792	645	671	631	398	299	464	350	193	718	238
7	-	69	195	37	159	672	176	1,028	629	507	464	655	152	249	464	333	203	390	189
8	-	28	196	23	152	558	130	726	617	366	522	715	239	55	324	232	198	263	176
9	-	104	72	14	158	584	102	658	651	507	621	665	296	143	426	69	274	317	116
10	-	33	65	8	107	285	146	688	560	558	435	667	389	215	429	313	123	283	111
11	-	59	25	42	87	294	138	618	483	396	318	691	196	286	438	299	162	243	105
12	-	39	70	38	62	366	119	649	630	506	423	494	141	258	518	196	163	304	143
13	-	28	65	43	135	198	74	673	493	538	655	552	170	445	731	198	310	284	173
14	-	30	17	15	153	255	104	675	697	982	811	398	118	633	914	358	395	147	197
15	-	12	1	38	156	355	99	801	412	1,032	1,042	486	130	803	675	447	483	341	185
16	-	36	41	10	140	422	91	652	610	1,119	968	684	198	1,083	806	602	452	302	242
17	15	10	0	13	211	425	31	660	572	718	1,130	631	194	1,755	1,290	771	881	275	314
18	7	4	6	32	293	713	298	626	928	990	1,125	771	353	2,165	1,238	590	597	312	333
19	17	23	0	66	429	777	77	395	1,257	1,122	915	631	451	1,470	956	454	678	311	340
20	28	10	6	28	523	637	53	713	1,569	1,287	1,096	764	714	2,109	637	443	765	466	356
21	8	3	0	54	431	603	57	558	1,277	1,320	854	723	783	1,961	392	461	641	479	628
22	22	43	12	143	640	384	32	752	1,107	1,248	827	639	750	1,230	453	434	574	378	382
23	19	30	0	134	562	561	88	551	1,007	1,082	829	575	514	574	525	459	616	366	490
24	15	6	25	235	697	661	118	474	998	733	1,290	722	385	924	485	456	773	418	843
Totals	131	1,089	1,422	1,329	6,688	13,967	4,607	14,730	18,948	21,559	19,778	15,874	8,524	18,554	15,226	10,158	9,998	9,466	6,745

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Hour End	10-Jul[a]	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul	29-Jul
1	1,028	829	258	120	392	170	558	519	256	419	574	493	616	458	116	113	106	31	122	90
2	1,143	802	236	307	318	155	605	521	199	422	517	527	330	316	109	96	201	57	142	57
3	993	735	149	247	219	131	610	420	217	357	310	405	331	238	82	84	128	34	92	51
4	1,008	935	188	155	197	141	443	301	291	180	359	410	304	336	87	52	113	27	125	71
5	932	772	211	72	21	107	443	441	153	400	429	342	261	375	76	89	105	34	64	53
6	817	576	330	126	14	113	449	302	178	442	583	467	312	239	90	149	130	34	42	85
7	751	576	161	130	19	86	363	302	165	317	540	401	205	291	83	122	104	39	54	57
8	642	470	155	105	16	80	380	267	147	236	346	268	200	200	55	63	72	33	75	52
9	486	383	147	172	147	103	303	253	184	169	218	252	202	39	44	45	60	83	70	47
10	479	383	200	294	122	68	301	293	187	290	310	304	161	31	20	39	40	88	44	43
11	384	281	80	111	109	71	263	177	200	193	295	273	275	299	49	66	47	91	31	47
12	587	458	113	118	94	74	259	114	216	222	273	223	190	277	68	29	40	65	43	35
13	653	487	109	147	84	140	236	124	180	250	257	215	165	209	68	49	60	70	27	40
14	775	189	446	158	163	249	345	129	170	284	284	249	262	137	56	28	71	101	55	24
15	825	198	663	248	208	208	305	122	166	311	187	224	196	138	56	49	118	44	44	77
16	536	199	226	157	128	223	248	119	208	262	226	358	191	174	81	56	67	65	52	32
17	460	268	357	205	144	268	359	88	191	295	308	344	213	182	48	45	88	44	30	44
18	514	244	123	241	230	284	338	122	216	294	330	359	174	197	61	56	76	61	49	25
19	681	325	166	175	54	128	288	140	210	269	329	347	195	194	78	102	43	93	60	32
20	989	178	333	122	78	283	231	185	182	320	313	358	191	143	60	86	37	113	53	20
21	1,118	327	292	184	81	252	199	125	197	337	321	223	246	100	81	131	27	113	48	27
22	738	258	332	257	108	258	196	134	194	404	320	329	309	105	77	356	21	87	55	43
23	690	293	163	200	91	368	332	161	347	369	233	418	310	779	69	115	20	98	74	43
24	1,061	482	78	263	111	400	607	372	386	522	470	464	409	284	73	113	26	121	72	50
Totals	18,290	10,648	5,516	4,314	3,148	4,360	8,661	5,731	5,040	7,564	8,332	8,253	6,248	5,741	1,687	2,133	1,800	1,626	1,523	1,145

[a] Data unavailable for the period 0000 - 1300. Counts for that period were estimated based on available July 10 data and the mean proportion and distribution pattern of counts for that time period on July 9 and 11.

Appendix A2. East bank Anvik River corrected sonar counts by hour and date, June 21 - July 29, 1990.

Hour End	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul[a]	05-Jul	06-Jul	07-Jul	08-Jul	09-Jul
1	-	12	0	17	20	75	91	19	51	75	601	908	278	802	87	138	80	180	120
2	-	58	19	140	39	24	172	129	220	212	906	452	326	609	71	151	132	149	91
3	-	286	19	210	205	70	144	215	168	251	619	436	266	279	73	29	36	163	111
4	-	25	52	8	33	81	11	104	87	387	552	241	135	160	51	45	44	119	40
5	-	21	2	8	17	90	14	160	56	277	473	323	125	274	25	129	52	153	59
6	-	4	1	5	19	29	29	28	18	410	377	179	278	305	75	47	24	198	29
7	-	0	0	18	46	40	15	13	14	451	317	365	125	129	75	50	32	187	43
8	-	1	0	3	3	32	20	79	53	320	227	179	47	84	23	10	24	86	29
9	-	0	0	7	6	19	14	19	5	70	44	344	30	134	21	16	28	84	35
10	-	2	0	8	0	41	6	15	7	68	42	267	116	118	19	30	11	81	21
11	-	0	0	7	5	16	28	17	9	62	75	256	33	90	23	11	11	84	29
12	-	0	0	6	4	22	17	29	11	55	68	188	17	49	20	22	39	81	10
13	-	0	2	0	7	16	10	15	6	35	53	256	3	26	12	19	36	111	11
14	-	0	0	0	17	27	15	24	1	36	35	119	20	36	25	16	23	95	19
15	-	2	0	0	53	9	7	15	5	38	20	101	13	61	40	19	8	75	84
16	-	0	2	4	25	12	16	28	6	36	26	87	83	84	26	29	12	103	79
17	-	0	0	6	14	24	20	21	6	40	21	344	94	95	28	50	11	36	115
18	-	0	7	11	28	19	406	30	5	36	58	387	98	148	65	118	27	106	360
19	1	0	5	2	26	12	92	25	2	26	52	127	136	243	122	140	42	86	405
20	1	5	0	6	24	20	8	8	19	57	35	276	105	234	103	178	64	99	386
21	1	3	0	8	27	18	31	13	17	53	67	184	158	415	168	160	124	211	576
22	5	3	15	6	36	36	15	11	85	127	160	386	230	468	17	133	342	111	598
23	13	0	18	11	33	15	25	33	61	504	467	253	357	413	202	191	275	193	593
24	6	4	39	18	44	28	17	20	59	908	493	192	671	575	202	98	194	162	609
Totals	27	426	181	509	731	775	1,223	1,070	971	4,534	5,788	6,850	3,744	5,831	1,573	1,829	1,671	2,953	4,452

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Hour End	10-Jul[b]	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul	29-Jul
1	742	381	60	30	30	54	95	343	148	319	214	338	205	463	122	102	95	172	77	22
2	472	184	43	28	39	52	245	273	246	396	304	462	323	416	101	100	191	272	50	1
3	688	355	58	43	37	44	320	186	292	614	467	716	387	351	144	86	223	75	65	2
4	295	182	50	21	26	42	272	142	195	369	221	328	348	258	70	85	44	57	44	10
5	379	204	36	25	14	31	245	114	127	250	107	267	109	139	30	69	34	37	20	5
6	291	221	34	23	26	26	153	68	113	92	49	141	25	253	38	70	68	22	18	0
7	349	233	8	18	15	18	98	26	34	156	58	230	63	64	32	45	28	36	23	1
8	221	140	21	15	12	16	144	22	52	80	23	64	48	139	18	31	22	24	19	3
9	243	142	6	12	7	14	44	15	5	12	13	31	29	176	22	45	70	15	40	2
10	223	175	8	12	19	8	24	23	5	34	14	55	43	200	67	53	56	11	32	0
11	180	93	14	35	21	0	19	11	11	13	8	12	32	421	31	65	50	17	46	1
12	127	107	20	12	2	5	6	1	0	12	5	7	5	82	18	36	12	22	69	4
13	104	76	4	10	2	11	5	25	0	5	1	7	3	115	8	8	41	25	4	1
14	230	161	14	5	5	10	2	12	2	4	1	0	4	95	12	4	28	17	23	0
15	386	95	23	16	11	17	3	4	1	7	0	1	27	117	5	46	14	11	30	2
16	431	66	14	9	10	26	8	10	2	7	0	1	14	215	68	20	13	10	23	2
17	671	23	43	7	21	36	25	7	4	7	2	36	70	137	50	17	16	23	20	0
18	385	93	3	57	11	30	23	7	15	5	5	9	184	117	52	23	12	14	38	0
19	289	77	13	31	6	84	18	5	122	35	5	61	106	316	82	65	26	17	43	0
20	465	94	30	31	16	162	82	9	428	111	25	117	289	131	95	111	54	54	0	0
21	623	107	36	34	19	67	60	23	63	107	53	145	298	153	157	52	37	30	2	1
22	755	88	25	33	8	152	126	27	175	243	57	151	320	136	174	182	65	30	0	0
23	690	79	45	26	15	200	286	148	317	266	194	217	697	298	249	120	104	34	3	0
24	733	67	46	25	15	208	430	72	138	262	122	170	862	129	71	95	78	73	4	1
Totals	9,972	3,443	654	558	387	1,313	2,733	1,573	2,495	3,406	1,948	3,566	4,491	4,921	1,716	1,530	1,381	1,098	693	58

[a] Data unavailable for sectors 17 - 21. Sectors counts were estimated based on mean proportion and distribution of counts for similar sectors on July 3 and 5.

[b] Data unavailable for the period 0000 - 1300. Counts for that period were estimated and distributed based on mean proportion and distribution of counts for that time period on July 9 and 10.

Appendix A3. West bank Anvik River sonar counts by sector, June 21 - July 29, 1990.

West Bank Sector	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul	09-Jul
1	8	134	66	47	234	291	244	445	411	365	73	34	153	109	94	87	37	1,640	1,773
2	19	355	374	300	1,462	2,598	1,235	4,775	3,669	3,941	1,757	862	1,375	1,908	1,133	874	442	4,618	2,942
3	44	255	396	194	1,846	4,649	1,397	4,707	6,169	6,050	5,265	4,511	2,370	6,270	5,362	2,793	2,575	1,709	988
4	34	156	229	263	1,937	4,331	990	3,083	6,553	8,731	8,220	8,050	3,368	7,805	6,068	3,277	3,723	706	327
5	14	77	142	169	691	1,117	487	1,092	1,246	1,323	1,927	1,160	551	1,382	948	705	1,083	131	66
6	3	25	46	137	258	504	113	323	460	632	1,397	558	227	402	342	460	498	70	58
7	4	4	26	39	56	107	20	69	74	78	369	110	42	52	135	218	226	30	19
8	0	1	29	47	21	47	5	29	38	31	65	40	24	17	55	117	115	28	16
9	0	23	30	58	62	142	54	65	93	173	339	209	107	155	314	510	369	129	111
10	0	34	36	22	17	51	21	29	53	98	111	85	99	94	168	285	198	79	121
11	3	10	30	23	51	53	13	50	47	75	101	111	80	115	189	287	262	95	108
12	0	1	6	26	29	45	13	34	52	41	105	67	50	109	166	204	170	75	98
13	0	11	6	4	18	25	10	16	53	18	34	45	39	76	142	181	146	76	67
14	0	0	1	1	3	5	4	6	22	3	8	13	23	25	33	61	70	31	25
15	0	0	3	1	1	2	0	3	3	2	3	9	10	12	38	50	40	20	11
16	1	0	0	0	1	1	3	5	6	1	6	9	6	20	40	48	45	28	14
Total	130	1,086	1,420	1,331	6,687	13,968	4,609	14,731	18,949	21,562	19,780	15,873	8,524	18,551	15,227	10,157	9,999	9,465	6,744

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West Bank Sector	10-Jul[a]	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul	29-Jul
1	2,575	2,562	403	1,041	1,574	1,520	3,538	1,798	1,149	1,382	572	297	449	1,145	247	282	397	123	410	236
2	4,804	5,320	1,286	1,390	1,110	1,313	3,231	1,803	1,834	2,821	2,340	2,306	1,843	1,854	503	544	606	290	544	210
3	1,405	1,368	1,746	1,189	262	530	1,694	1,031	1,339	2,430	3,773	3,884	2,431	1,522	536	439	385	280	328	132
4	371	264	421	237	85	143	383	304	382	489	1,276	900	580	857	242	184	178	227	180	75
5	98	99	545	214	12	23	47	57	54	77	124	94	70	148	139	91	80	45	27	30
6	62	39	82	25	21	13	55	68	30	27	51	25	40	28	45	29	20	22	47	233
7	19	10	9	10	15	14	51	63	27	23	61	30	18	10	9	9	6	37	11	6
8	18	12	3	8	9	14	23	14	33	20	36	34	17	9	8	6	11	2	2	3
9	120	78	26	30	34	37	92	87	73	90	128	92	60	12	31	52	45	9	18	11
10	130	82	37	24	32	32	43	50	48	57	97	82	44	12	37	31	35	15	23	8
11	115	71	42	30	63	39	88	54	56	93	101	71	41	9	22	39	27	26	33	19
12	74	5	14	16	22	12	29	29	44	30	31	25	17	5	14	16	15	21	21	17
13	61	23	22	34	33	14	19	32	35	25	24	15	12	12	33	26	30	28	16	14
14	25	14	11	17	7	12	22	29	19	13	20	13	7	12	21	12	49	59	35	9
15	13	10	14	7	16	14	12	23	25	22	24	13	9	16	31	26	60	71	79	14
16	14	8	14	8	15	13	22	24	49	11	26	21	21	10	51	33	34	190	92	39
Total	9,904	9,965	4,675	4,280	3,310	3,743	9,349	5,466	5,197	7,610	8,684	7,902	5,659	5,661	1,969	1,819	1,978	1,445	1,866	1,056

[a]Data unavailable for all sectors during the period 0000 - 1300. Counts were estimated and distributed by sector based on mean proportion and distribution pattern for that time period on July 9 and 11.

Appendix 4A. East bank Anvik River sonar counts by sector, June 21 - July 29, 1990.

East Bank Sector	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul	a05-Jul	06-Jul	07-Jul	08-Jul	09-Jul
17	1	3	6	19	60	159	25	94	75	166	95	286	109	294	113	80	55	79	48
18	2	1	2	4	99	56	24	44	113	145	194	460	248	350	85	128	102	193	98
19	0	0	0	1	24	17	15	40	121	198	207	427	410	579	141	152	111	186	109
20	0	0	0	2	13	10	5	17	36	109	118	385	439	542	107	106	58	73	41
21	4	0	0	1	2	4	3	2	13	69	54	148	93	153	43	49	32	45	20
22	0	1	0	2	1	17	6	10	9	39	16	154	185	157	24	21	24	26	14
23	0	6	18	15	38	28	60	60	1	29	30	186	114	105	19	27	34	28	7
24	2	20	24	20	19	25	49	75	1	27	36	108	36	33	13	15	26	31	12
25	0	56	6	25	35	47	41	116	46	187	195	303	20	56	122	171	156	199	157
26	2	60	12	55	40	18	47	71	63	650	570	756	53	264	305	369	335	485	202
27	5	66	26	76	38	14	75	81	102	718	798	942	344	468	190	255	232	378	241
28	3	103	44	135	104	117	213	188	79	1,321	1,829	1,444	347	928	197	245	291	653	624
29	5	78	38	104	177	219	340	194	134	615	1,135	910	793	1,058	135	139	155	372	861
30	4	28	3	36	54	40	169	67	110	176	367	249	438	468	50	47	43	118	820
31	0	4	1	13	22	3	98	11	62	77	123	67	77	338	21	18	13	59	877
32	0	1	0	1	5	0	53	1	2	7	26	22	39	37	5	8	5	25	321
Total	28	427	180	509	731	774	1,223	1,071	967	4,533	5,793	6,847	3,745	5,830	1,570	1,830	1,672	2,950	4,452

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East Bank Sector	10-Jul[b]	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul	29-Jul
17	27	7	12	4	2	6	43	40	55	81	66	56	38	29	228	91	110	102	40	0
18	50	5	4	3	6	10	28	21	61	83	22	26	30	45	163	62	80	55	22	0
19	58	9	1	5	1	2	19	6	35	81	21	23	23	37	74	22	24	11	8	0
20	22	3	0	1	1	1	5	3	6	19	7	11	36	20	38	17	11	21	12	0
21	10	0	0	1	2	0	1	1	1	4	2	3	87	96	16	17	9	277	9	0
22	7	0	1	1	0	0	0	0	0	1	0	0	19	62	45	24	15	15	17	0
23	4	1	0	1	1	0	0	0	1	1	5	1	6	44	33	23	14	13	20	0
24	6	0	0	1	0	1	0	0	1	2	4	0	1	70	15	3	4	8	15	0
25	76	0	1	2	3	7	12	7	20	25	20	22	13	76	130	83	84	71	67	0
26	121	40	27	49	26	33	97	69	102	166	87	103	79	263	257	144	117	103	102	0
27	156	68	39	73	51	60	188	128	158	265	182	202	181	467	242	151	135	105	109	1
28	513	367	144	163	131	275	866	463	535	1,001	540	824	486	419	309	151	166	63	150	3
29	839	736	136	132	96	272	1,004	451	587	1,849	854	1,373	1,349	804	339	170	240	88	198	11
30	915	902	94	68	42	156	679	228	271	594	188	397	939	906	321	157	250	79	104	13
31	1,049	1,088	72	43	16	59	327	91	150	310	80	129	888	1,011	188	93	171	40	75	7
32	462	534	31	23	8	14	112	20	78	83	16	23	148	356	31	32	41	7	11	1
Total	4,315	3,760	562	570	386	896	3,381	1,528	2,061	4,565	2,094	3,193	4,323	4,705	2,429	1,240	1,471	1,058	959	36

[a]Data unavailable for sectors 17 - 21. Sectors counts were estimated based on mean proportion and distribution of counts for similar sectors on July 3 and 5.

[b]Data unavailable for the period 0000 - 1300. Counts for that period were estimated and distributed based on mean proportion and distribution of counts for that time period on July 9 and 11.

Appendix A.5. Anvik River salmon beach seine catch by species, sex, and date, 1990.

Date	Number Of Sets	Chum			Chinook			Pink		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
25-Jun	1	0	0	0	0	0	0	0	0	0
26-Jun	1	0	0	0	0	0	0	0	0	0
27-Jun	5	40	21	61	0	0	0	0	0	0
28-Jun	0									
29-Jun	0									
30-Jun	0									
01-Jul	2	1	2	3	0	0	0	0	0	0
02-Jul	2	3	3	6	0	0	0	0	0	0
03-Jul	1	0	0	0	0	0	0	0	0	0
04-Jul	0									
05-Jul	0									
06-Jul	1	38	45	83	0	0	0	0	0	0
07-Jul	1	23	20	43	0	0	0	0	0	0
08-Jul	1	39	41	80	0	0	0	0	0	0
09-Jul	0									
10-Jul	0									
11-Jul	0									
12-Jul	1	4	8	12	0	0	0	0	0	0
13-Jul	0									
14-Jul	1	2	2	4	0	0	0	0	0	0
15-Jul	0									
16-Jul	2	4	9	13	0	0	0	0	0	0
17-Jul	1	1	24	25	0	0	0	0	0	0
18-Jul	0									
19-Jul	0									
20-Jul	1	16	23	39	0	0	0	0	0	0
21-Jul	0									
22-Jul	1	3	20	23	0	0	0	0	0	0
23-Jul	0									
24-Jul	1	12	19	31	0	0	0	0	0	0
25-Jul	0									
26-Jul	0									
27-Jul	0									
28-Jul	1	1	4	5	0	0	0	0	0	0
Total	24	187	241	428	0	0	0	0	0	0

Appendix A.6. Age and sex composition of Anvik River summer chum salmon, 1972 - 1990.[a]

Year	Sample Number			Number of Fish: Age 0.2			Age 0.3			Age 0.4			Age 0.5		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	167	153	320	0	0	0	25	37	62	138	115	253	4	1	5
1973	265	518	783	11	37	48	204	401	605	49	79	128	1	1	2
1974	245	157	402	12	24	36	197	120	317	34	12	46	2	1	3
1975	270	314	584	4	17	21	253	288	541	13	9	22	0	0	0
1976	281	320	601	5	4	9	43	35	78	233	281	514	0	0	0
1977	191	398	589	20	111	131	161	270	431	7	15	22	3	2	5
1978	289	263	552	0	1	1	210	180	390	79	82	161	0	0	0
1979	273	306	579	2	12	14	154	193	347	115	99	214	2	2	4
1980	167	258	425	0	1	1	147	226	373	20	31	51	0	0	0
1981	151	182	333	0	0	0	49	67	116	99	115	214	3	0	3
1982	117	265	382	4	17	21	75	181	256	37	65	102	1	2	3
1983	183	238	421	0	4	4	99	142	241	83	90	173	1	2	3
1984	138	215	353	2	6	8	117	189	306	19	20	39	0	0	0
1985	233	294	527	0	11	11	172	225	397	59	58	117	2	0	2
1986	205	281	486	0	2	2	59	89	148	143	186	329	3	4	7
1987	190	355	545	0	10	10	125	238	363	56	100	156	9	7	16
1988	180	351	531	1	30	31	129	282	411	48	37	85	2	2	4
1989	199	389	588	0	9	9	55	179	234	143	201	344	1	0	1
1990	172	227	399	3	12	15	98	169	267	67	45	112	4	1	5

Year	Percent of Sample			Percent of Total Sample: Age 0.2			Age 0.3			Age 0.4			Age 0.5		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	52.2	47.8	100.0	0.0	0.0	0.0	7.8	11.6	19.4	43.1	35.9	79.1	1.3	0.3	1.6
1973	33.8	66.2	100.0	1.4	4.7	6.1	26.1	51.2	77.3	6.3	10.1	16.3	0.1	0.1	0.3
1974	60.9	39.1	100.0	3.0	6.0	9.0	49.0	29.9	78.9	8.5	3.0	11.4	0.5	0.2	0.7
1975	46.2	53.8	100.0	0.7	2.9	3.6	43.3	49.3	92.6	2.2	1.5	3.8	0.0	0.0	0.0
1976	46.8	53.2	100.0	0.8	0.7	1.5	7.2	5.8	13.0	38.8	46.8	85.5	0.0	0.0	0.0
1977	32.4	67.6	100.0	3.4	18.8	22.2	27.3	45.8	73.2	1.2	2.5	3.7	0.5	0.3	0.8
1978	52.4	47.6	100.0	0.0	0.2	0.2	38.0	32.6	70.7	14.3	14.9	29.2	0.0	0.0	0.0
1979	47.2	52.8	100.0	0.3	2.1	2.4	26.6	33.3	59.9	19.9	17.1	37.0	0.3	0.3	0.7
1980	39.3	60.7	100.0	0.0	0.2	0.2	34.6	53.2	87.8	4.7	7.3	12.0	0.0	0.0	0.0
1981	45.3	54.7	100.0	0.0	0.0	0.0	14.7	20.1	34.8	29.7	34.5	64.3	0.9	0.0	0.9
1982	30.6	69.4	100.0	1.0	4.5	5.5	19.6	47.4	67.0	9.7	17.0	26.7	0.3	0.5	0.8
1983	43.5	56.5	100.0	0.0	1.0	1.0	23.5	33.7	57.2	19.7	21.4	41.1	0.2	0.5	0.7
1984	39.1	60.9	100.0	0.6	1.7	2.3	33.1	53.5	86.7	5.4	5.7	11.0	0.0	0.0	0.0
1985	44.2	55.8	100.0	0.0	2.1	2.1	32.6	42.7	75.3	11.2	11.0	22.2	0.4	0.0	0.4
1986	42.2	57.8	100.0	0.0	0.4	0.4	12.1	18.3	30.5	29.4	38.3	67.7	0.6	0.8	1.4
1987	34.9	65.1	100.0	0.0	1.8	1.8	22.9	43.7	66.6	10.3	18.3	28.6	1.7	1.3	2.9
1988	33.9	66.1	100.0	0.2	5.6	5.8	24.3	53.1	77.4	9.0	7.0	16.0	0.4	0.4	0.8
1989[c]	34.4	65.6	100.0	0.0	1.2	1.2	9.4	28.5	37.9	24.8	35.9	60.7	0.1	0.0	0.1
1990[c]	48.7	51.3	100.0	0.6	2.5	3.2	26.0	39.1	65.1	18.8	11.3	30.1	1.2	0.4	1.6

[a] Samples collected by carcass survey 1972-1981, by beach seine 1983-1990, and by both methods combined in 1982.
[b] Sample percentages not weighted by time period or escapement counts unless otherwise noted.
[c] Sample percentages weighted by time period and escapement counts.

Appendix A.7. Age and sex composition of Anvik River chinook salmon escapement samples, 1972-1990.[a]

Year	Numbers of Fish: Sample Male	Sample Female	Sample Total	Age 4 Male	Age 4 Female	Age 4 Total	Age 5 Male	Age 5 Female	Age 5 Total	Age 6 Male	Age 6 Female	Age 6 Total	Age 7 Male	Age 7 Female	Age 7 Total
1972	10	5	15	0	0	0	8	0	8	2	5	7	0	0	0
1973	6	4	10	1	0	1	0	0	0	5	3	8	0	1	1
1974	0	0	0												
1975	6	2	8	1	0	1	4	1	5	1	1	2	0	0	0
1976	33	12	45	6	0	6	25	5	30	2	7	9	0	0	0
1977	58	59	117	2	1	3	27	6	33	27	48	75	2	4	6
1978	36	41	77	13	0	13	10	1	11	13	39	52	0	1	1
1979	37	9	46	17	0	17	14	0	14	6	6	12	0	3	3
1980	41	42	83	19	1	20	21	22	43	1	16	17	0	3	3
1981	109	154	263	33	1	34	61	36	97	15	116	131	0	1	1
1982	100	38	138	47	1	48	47	5	52	6	32	38	0	0	0
1983	173	133	306	56[b]	0	56	84	26	110	33	104	137	0	3	3
1984	162	114	276	29	4	33	108	30	138	25	74	99	0	6	6
1985	25	8	33	10	0	10	10	3	13	5	5	10	0	0	0
1986	53	89	142	0	1	1	44	27	71	6	48	54	3	13	16
1987	92	130	222	21	0	21	22	7	29	48	116	164	1	7	8
1988	173	73	246	75	0	75	70	24	94	26	41	67	2	8	10
1989	226	155	381	17[b]	0	17	149	38	187	60	106	166	0	11	11
1990	148	252	400	106[b]	0	106	86	18	104	56	119	175	4	11	15

Year	Sample Male	Sample Female	Sample Total	Percent of Total Sample[c]: Age 4 Male	Age 4 Female	Age 4 Total	Age 5 Male	Age 5 Female	Age 5 Total	Age 6 Male	Age 6 Female	Age 6 Total	Age 7 Male	Age 7 Female	Age 7 Total
1972	66.7	33.3	100.0	0.0	0.0	0.0	53.3	0.0	53.3	13.3	33.3	46.7	0.0	0.0	0.0
1973	60.0	40.0	100.0	10.0	0.0	10.0	0.0	0.0	0.0	50.0	30.0	80.0	0.0	10.0	10.0
1974	0.0	0.0	0.0												
1975	75.0	25.0	100.0	12.5	0.0	12.5	50.0	12.5	62.5	12.5	12.5	25.0	0.0	0.0	0.0
1976	73.3	26.7	100.0	13.3	0.0	13.3	55.6	11.1	66.7	4.4	15.6	20.0	0.0	0.0	0.0
1977	49.6	50.4	100.0	1.7	0.9	2.6	23.1	5.1	28.2	23.1	41.0	64.1	1.7	3.4	5.1
1978	46.8	53.2	100.0	16.9	0.0	16.9	13.0	1.3	14.3	16.9	50.6	67.5	0.0	1.3	1.3
1979	80.4	19.6	100.0	37.0	0.0	37.0	30.4	0.0	30.4	13.0	13.0	26.1	0.0	6.5	6.5
1980	49.4	50.6	100.0	22.9	1.2	24.1	25.3	26.5	51.8	1.2	19.3	20.5	0.0	3.6	3.6
1981	41.4	58.6	100.0	12.5	0.4	12.9	23.2	13.7	36.9	5.7	44.1	49.8	0.0	0.4	0.4
1982	72.5	27.5	100.0	34.1	0.7	34.8	34.1	3.6	37.7	4.3	23.2	27.5	0.0	0.0	0.0
1983	56.5	43.5	100.0	18.3	0.0	18.3	27.5	8.5	35.9	10.8	34.0	44.8	0.0	1.0	1.0
1984	58.7	41.3	100.0	10.5	1.4	12.0	39.1	10.9	50.0	9.1	26.8	35.9	0.0	2.2	2.2
1985	75.8	24.2	100.0	30.3	0.0	30.3	30.3	9.1	39.4	15.2	15.2	30.3	0.0	0.0	0.0
1986	37.3	62.7	100.0	0.0	0.7	0.7	31.0	19.0	50.0	4.2	33.8	38.0	2.1	9.2	11.3
1987	41.4	58.6	100.0	9.5	0.0	9.5	9.9	3.2	13.1	21.6	52.3	73.9	0.5	3.2	3.6
1988	70.3	29.7	100.0	30.5	0.0	30.5	28.5	9.8	38.2	10.6	16.7	27.2	0.8	3.3	4.1
1989	59.3	40.7	100.0	4.5	0.0	4.5	39.1	10.0	49.1	15.7	27.8	43.6	0.0	2.9	2.9
1990	63.0	37.0	100.0	26.5	0.0	26.5	21.5	4.5	26.0	14.0	29.8	43.8	1.0	2.8	3.8

[a]Samples collected mainly by carcass survey. In some years a very few fish were also collected by beach seine or hook and line.
[b]Includes one age-3 male.
[c]Sample percentages not weighted by time period or escapement counts.